

THE SCIENCE OF THE SŪLBA

A STUDY IN EARLY HINDU GEOMETRY,

(Readership Lectures for the year 1931)

BY

BIBHUTIBHUSAN DATTA

हिरण्येन पात्रेण सत्यस्यापिहितं मुखम् ।

तत्त्वं पुषन्नपाहणं सत्यधर्माय दृष्टये ॥

ईशोपनिषद्

“The face of Truth is covered with a shining lid, that do
thou remove, O Fosterer, so that Truth may be seen ”



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तृप्यन्तामृषयः सर्वे यैर्दृष्टं शुल्वविज्ञानम् ।

व्यासो यैश्च कृतस्तस्य तेभ्यश्चेदं नमो नमः ॥

ॐ शान्तिः शान्तिः शान्तिः ॥

PREFACE

In this book an attempt has been made to study the Vedic rites of the *Agni-cayana* (or "the construction of the Fire-altar") from a point of view, purely secular, quite different from that of unravelling their deep mysticism and highly speculative philosophy. The whole purpose has been to get as much insight as possible into the knowledge and achievements of the Hindus in the science of mathematics, more particularly in its branch of geometry. The *Agni-cayana* reveals an important aspect of the Hindu genius of which the student of the Vedic culture is apt to lose sight. Most scholars, when they think of the genius of the Vedic Hindu, are naturally more attracted by his noble religion, sublime philosophy, enormous extent and most varied character of his rich literature, and charming devotional poetry. But the Vedic Hindu, in his great quest of the *Parā-vidyā* ("Supreme knowledge"), *Satyasya Satyam* ("Truth of truths," "Absolute Truth"), made progress in the *Apārā-vidyā* ("inferior knowledge," "relative truths"), including the various arts and sciences, to a considerable extent, and with a completeness which is unparalleled in antiquity. Of these the special concern of this volume is with the Vedic science of geometry, technically called by the name *Sulba*.

The writer is fully conscious of his limitations to perform in the proper way the arduous task that he has undertaken. Truly he feels, to speak after the immortal poet Kālidāsa,

क शस्त्रविद्वत्तविद्या क चाल्पवर्षिया मति ।
तितीर्षुरुद्धुपेनापि दुस्तरमस्मि सागरम् ॥

How great is the science which revealed itself in the *Sulba* and how meagre is my intellect! I have aspired to cross the unconquerable ocean in a mere raft. Moreover the work had had to be done hurriedly within a short time at his disposal just on the eve of his retirement from active life in the University in 1930 amidst other preparatory arrangements consequent thereto. So it could not be made as comprehensive and thorough as it should have been. It is nevertheless the author's confident hope that this imperfect sketch will create a lively interest in the early Hindu geometry amongst the historians of mathematical sciences.

It is a pleasure to express indebtedness to my teacher Professor Ganesh Prasad for his interest and encouragement for the work. In deference to his wish I delivered by special invitation of the authorities a course of six lectures on the science of the *Sulba* in the University of Calcutta during December 1931. I tender grateful thanks to Mr Atul Chandra Ghatak Superintendent and the staff of the Calcutta University Press for kindly expediting the book through the Press in order to help me to go back to my retirement earlier. Above all I remember with pleasure the name of my younger brother Dr Binode Behari Datta M.A. Ph.D. for his help and association in every way in this book.

BIBHUTIBHUSAN DATTA

Calcutta 26th July 1932

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ABBREVIATIONS

<i>IpSl</i>	= <i>Īpastamba Sulba</i>
<i>IpSr</i>	= <i>Īpastamba Śrauta</i>
<i>BSl</i>	= <i>Baudhāyana Sulba</i>
<i>BSr</i>	= <i>Baudhāyana Śrauta</i>
<i>KapS</i>	= <i>Kapisthīla Samhita</i>
<i>hSl</i>	= <i>Katyāyana Sulba</i>
<i>hSlP</i>	= <i>Katyāyana Sulba Parisista</i>
<i>hSr</i>	= <i>Katyāyana Śrauta</i>
<i>KtS</i>	= <i>Kathala Samhita</i>
<i>ManS</i>	= <i>Maitrayaniya Samhita</i>
<i>MaSl</i>	= <i>Maitrayaniya Sulba</i>
<i>MaSl</i>	= <i>Manava Sulba</i>
<i>MaSr</i>	= <i>Manava Śrauta</i>
<i>PañBr</i>	= <i>Pancāśikā Brahmana</i>
<i>RV</i>	= <i>Rg veda</i>
<i>SBE</i>	= <i>Sacred Books of the East Series</i>
<i>SBr</i>	= <i>Satapatha Brahmana</i>
<i>TBr</i>	= <i>Taittiriya Brahmana</i>
<i>TS</i>	= <i>Taittiriya Samhita</i>
<i>VS</i>	= <i>Vajasaneyi Samhita</i>
<i>ZDMG</i>	= <i>Zeitschrift der deutschen morgenländischen Gesellschaft</i>

CHAPTER I

SULBAS

The *Sulbas*, or as they are more commonly known at present amongst oriental scholars, the *Sulba-sūtras*, are manuals for the construction of altars which are necessary in connexion with the sacrifices of the Vedic Hindus. They are sections of the *Kalpa-sūtras*, more particularly¹ of the *Srauta-sūtras*, which form one of the six *Vedāṅgas* (or “The Members of the Veda”) and deal specially with rituals or ceremonies. Each *Srauta-sūtra* seems to have its own *Sulba* section. So there were, very likely, several such works in ancient times.² At present we know, however, of only seven *Sulba-sūtras*, those belonging to the *Srauta-sūtra* of Baudhāyana, Āpastamba, Kātyāyana,

¹ The *Kalpa-sūtras* are broadly divided into two classes, the *Grhya-sūtras* (or “The rules for ceremonies relating to family or domestic affairs” such as marriage, birth, etc.) and the *Srauta sūtras* (“The rules for ceremonies ordained by the Veda” such as the preservation of sacred fires, performance of the sacrifices, etc.) The *Sulba sūtras* belong to this latter class.

² We have it on the authority of Patañjali (150 B C), the Great Commentator of Panini’s Grammar, that there were as many as 1,131 or 1,137 different schools of the *Veda*.

“एकविंशतिधा वा ह्युच्यन्ते, एकशतमध्वर्युशाखाः ।

सहस्रवर्त्मा सामवेदः, नवधा आयुर्वर्णो वेदः पञ्चदशमेदो वा ॥”

Or “There were 21 different schools of the *Rg veda*, 101 schools of the *Yajur-veda*, 1,000 of the *Sāma veda*, and 9 or 15 of the *Atharva-veda*.” Each school of the *Veda* had its own *Srauta sūtra* and hence probably its own *Sulba*. Thus it seems that there were numerous manuals of geometry in ancient India. But most of them are now lost.

Manava Maṇṭrayana Varaha and Vadhula¹ The 6 manuals are also found separately

As related to the different *Vedas* the *Sulba sūtras* of Baudhayana Āpastamba Manava Maṇṭrayana and Varaha belong to the *Kṛṣṇa Yajur veda* and the *Kaṭyayana Sulba sūtra* to the *Sūlla Yajur veda*

It was perhaps primarily in connexion with the construction of the sacrificial altars of proper size and shape that the problems of geometry and also of arithmetic and algebra presented themselves and were studied in ancient India just as the study of astronomy is known to have begun and developed out of the necessity for fixing the proper time for the sacrifice² At any rate from the *Sulba sūtras* we get a glimpse of the knowledge of geometry that the Vedic Hindus had³ Incidentally they furnish us with a few other subjects of much mathematical interest

Of all the extant *Sulbas* that of the Baudhayana is the biggest and is also perhaps the oldest It is divided into three chapters The first chapter contains 116 *sūtras* (aphorisms) of which the opening two are merely introductory *sūtras* 3-21 define the various measures ordinarily employed in the *Sulbas* *sūtras* 22-62 give the more important of the geometrical propositions necessary for the construction of the sacrificial altars and *sūtras* 63-116 deal briefly with the relative positions

¹ I th comments y f K ra nd m on th Ap st mb S lba (: 11) v f d ref enc to tw the w l Mal k S lb nd H any k s s lba wh h a n t l bl n w Th r ls a q t t n fr m the l tte wo l (ApSl 10)

² B bhu bh sh n Datt The S p and D pment f th H nd G t Ind H t Quat V l 5 (1903) pp 479-51

³ Th r s n to belov th t daby d with th p r t l g ometry th Sulbas th V d s Ec l p r i t h d lso n e a n g e ometry s th r ec t p o p ty

and spatial magnitudes of the various *vedis* (or "altars") The second chapter consists of 86 *sūtras* of which the major portion, *sūtras* 1-61, is devoted to the description of the spatial relations in the different constructions of the *Agnis* (or "the large Fire-altars made of bricks") in general, and the remaining portion, *sūtras* 62-86, elaborates the construction of the two simplest *Agnis*, viz., the *Gārhapatyā-citi* (or "The House-holder's Fire-altar") and *Chandas-citi*¹ (or "The *Agni* made, as it were, of *mantras* instead of bricks") The third chapter, in altogether 323 *sūtras*, describes the construction of as many as seventeen different kinds of *Kāmya Agnis* (or "the altars for the sacrifices performed with a view to attain definite objects") of rather complex nature In case of some, the description is quite elaborate and minute in details, but in other cases it is less so

The *Sulba-sūtra* of Āpastamba is broadly divided into six *patalas* (or "sections") Of these the first, third and the fifth are each subdivided again into three *adhyāyas* (or "chapters") and each of the remaining sections into four chapters So that altogether the work contains twenty-one chapters and 223 *sūtras* The first section of the manual, chapters i-iii, gives the important geometrical propositions required for the construction of altars The second section of the chapters iv-vii, describe the relative positions of the various *vedis* and their spatial magnitudes Unlike Baudhāyana, Āpastamba here indicates

¹ In case of the *Chandasciti*, the *agnic* ("the Fire altar-builder") draws on the ground the *Agni* of the prescribed shape, ordinarily of the primitive shape of the falcon He then goes through the whole prescribed process of construction imagining all the while as if he is placing every brick in its proper place with the appropriate *mantras* The *mantras* are, indeed, muttered but the bricks are not actually laid Hence the name *Chandasciti*, that is, the *citi* or altar made up of *chandas* or Vedic *mantras* instead of bricks or loose mud pieces

briefly also the methods of their construction. They are of course the particular applications of the general geometrical theorems taught in the earlier section. The remaining sections of the *Āpastamba Sulba sūtra* comprising the chapters viii-xxi deal with the construction of the *Āmya Agnis*. It is noteworthy that almost the same set of geometrical propositions are taught by both Baudhayana and Āpastamba. But the latter has treated of a smaller number of varieties of the *Āmyas* than the former. For instance Āpastamba teaches only one kind of *ratha cakra citi* (or the wheel shaped altar) whereas Baudhayana gives two.

The *Sulba sūtra* of Kātyāyana also known as *Kātyāyana Sulba parīśista* or *Kātyāyana Sulba parīśista* is divided into two parts. The first part is composed in the style of the *sūtras* or aphorisms as those noted above while the second part is composed in verses. The earlier part is again subdivided into seven *bandhas* (or short sections) containing altogether 90 *sūtras*. It teaches the geometrical propositions, the different measures employed in the work and the relative positions and spatial relations for the different constructions of the *Āgnis*. This manual does not treat of the construction of the *Āmya Agnis*. It is because that subject has been treated in a different chapter of the *Kātyāyana Śrauta sūtra*¹. The second part comprises nearly about 40 or 48 verses. It gives mainly a description of the measuring tape (*raju*).

¹ AS Ch p x i

² The *raju* is a functionary but the total number of *raju* is the *P* of the *Kātyāyana Sulba*. The manuscript of it that preserved in the Library of the India Office, London (No. E. 363) has 48 *raju* while the manuscript of the *Bhadrak* in the Poon (No. 74 of A. 1881-8) has only 40. The latter MS also lists the commentaries of M. B. D. on this manual and has 43 verses.

the gnomon, the attributes of an expert altar-builder and also a few general rules for his conduct. Some of the processes of construction described in the earlier part together with a few other new matters, though of comparatively minor importance, also appear there. I think the title *Kātyāyana Śulba-parīśista* or ("The Appendix to the *Śulba* of Kātyāyana") was originally designed for this part and should be kept reserved to it, even now. For it is really a sort of an appendix to the earlier part, the *Kātyāyana Śulba* proper. The commentator Rāma is also of the same opinion as we are. And the same differentiation is found to have been scrupulously maintained by Yājñika Deva, the commentator of the *Kātyāyana Śrauta-sūtra*. Kātyāyana observes that the second part, especially the recapitulations in it, was meant to help those whose intellects are too poor to be able to fully grasp the inner meanings of the compositions in the *sūtra* style. Compared with the works of Baudhāyana and Āpastamba, the *Śulba* of Kātyāyana presents some interesting features as it exhibits the whole body of geometrical knowledge required for the Vedic altar-builder in a more systematic form.

The *Śulba sūtra* of Manu is a small treatise composed in both prose and verse. It is divided into seven *khandas* (or "parts," "sections"). In the first section is given a description of the measuring tape, the gnomon, measures, four methods of determining the cardinal directions and also a method of constructing a square on a given straight line. It may be noted that we do not find in the Āpastamba and Baudhāyana *Śulba-sūtras* any method of determining the cardinal directions, though it is essentially necessary for the proper construction of the sacrificial altars to have an accurate knowledge about them. They proceed on the assumption that the cardinal directions are already known. Kātyāyana teaches three methods for the

same while Manu teaches as many as four. The sections in vi treat of the relative positions spatial magnitudes and also the methods of the construction of the the different *vedis*. Here we find mention of certain *vedis* e.g. the *Pakayajñiki*, *Maruti* and *Varuni vedis* which are not included in the abovementioned manuals. The last section of the *Manara Sulba sutra* furnishes us with some hints about the sacrificial fees. It also describes the method of the construction of the *Suparna citi*. This *citi* is not found in other *Sulba sutras*. But for the head its spatial magnitudes are the same as those of the most primitive *citi* the *Saptavidha saratni pradēśa caturasra śyena citi* described by Baudhayana and others.

The *Maitrayaniya Sulba sutra* is a different recension of the *Manara Sulba sutra*. They cover almost the same ground and more than that many passages of them are identical. But still they should not be mistaken as one and the same work. The arrangement of matter in them is not parallel. And there are also other marks of distinction between them. The *Maitrayaniya Sulba sutra* is comprised of four *khandas* (or sections).

The *Varaha Sulba sutra* is very closely related to the above two works. There are found several repetitions between these works. This will not seem strange if we remember that they belong to the same school of the *Ārsna Yajur veda*. Similarly we find in these *Sulba sutras* repetition of a few verses of the *Katyajana Sulba parīśiṣṭa*. The *Varaha Sulba sutra* is broadly divided into three parts and each part is again subdivided into several sections.

As regards their importance the available *Sulba sutras* can sharply be divided into two classes. The first class will include the manuals of Baudhayana, Apastamba and Katyayana. They give us an insight into the early

state of Hindu geometry before the rise and advent of the Jaina Sect (500-300 B C) ¹ The *Sulba-sūtras* of Mānava, Vārāha, Maitrāyana and Vādhula add practically very little to our stock of information in this respect. So they may be considered to be of minor importance from our point of view.

In the title *Sulba-sūtra*, the word *sūtra* means an "aphorism," "a short rule." It simply describes the style of the composition of the works and has practically no reference to their subject-matter. The science itself is really called the *Sulba*. And that is, in fact, the original title of the manuals. It is by this title that the *Sulba-sūtra* of Āpastamba has been mentioned in his *Srauta-sūtra* ². The commentators are oftentimes found to speak of the *Sulba* of Baudhāyana, the *Sulba* of Āpastamba, etc. This will be further confirmed by the commonly known title of the second part of the work attributed to Kātyāyana, namely the *Sulba-parīśista* (or "The Appendix to the *Sulba*") and also by the title *Sulbi-kṛyā* (or "The Practice of the *Sulba*") given to that appendix in itself. Thus it is proved conclusively that the true name of the subject is *Sulba*. As the *Sulba* deals with the science of geometry and its application as known amongst the early Hindus, we conclude that the earliest Hindu name for geometry was *Sulba*. Geometry was then sometimes also called *Rajju*, as is evident from the opening sūtra of the *Sulba* of Kātyāyana, "I shall speak of the 'Collection of (rules regarding) the *Rajju*'." There are many other reliable pieces of evidence leading strongly to the same conclusion ³.

¹ For an insight into Hindu geometry after the advent of the Jainas the reader is referred to the author's article, "Geometry in the Jaina Cosmography," in *Quellen und Studien zur Geschichte der Mathematik*, Abteilung B, Bd 1, 1930, pp 245-254.

² *ĀpŚr*, xvii 26 2

³ Bibhutibhushan Datta, "Origin and History of the Hindu Names

In Sanskrit the words *śulba* and *raju* have the identical significance which is ordinarily a rope a cord. The word *śulba* or *śulva* is derived from the root *śulb* or *śulv* meaning to measure and hence its etymological significance is measuring or act of measurement. From that it came to denote a thing measured and consequently a line (or surface) as well as an instrument of measurement or the unit of measure. Thus the terms *śulba* or *raju* have four meanings (1) mensuration—the act and process of measuring (2) line (or surface)—the result obtained by measuring (3) a measure—the instrument of measuring and (4) geometry—the art of measuring. In the ancient literature of the Hindus we indeed find mention of three kinds of measure—linear superficial as well as voluminal—having the same epithet *raju*. In the *Sulbas* the measuring tape is called *raju*. And we further find there the use of the word in the sense of a line also. For instance we have the term *akṣaya raju* = diagonal line. *Katya* *yana* observes ¹ (The terms) *īkaraṇi* (producer) *tat karaṇi* (that producer) *tiryakman* (transverse measurer) *parśvam n* (side measurer) and *akṣaya* (diagonal) *raju*s are (lines).

In the *Manava Sulba*² and *Maitra-janiya Sulba*³ the science of geometry is called the *Sulba vijnana* (or the Science of the *Sulba*)⁴. One who was well versed in that

for Geometry. *Qu. Ue. and Stud. n. 2 G. 1 d. M. 11. Abte. 1 B. Bd.*
1 1930 [p. 113-9]

¹ *KS. 1. 7*

² *Th. t. d. k. a. t. k. etc.*

³ *MāŚ. 1.*

⁴ *V. Ś. Ch.*

⁵ The term also the term *śulba* and *śulba-p* precede for a expert in the *Śulba* will furnish the proper conclusion as regards the early history of geometry.

science was called in ancient India as *samlhyājña* (or "the expert in Number,"), *parimāṇājña* ("the expert in measuring"), *sama sūtra-nirañchaka* ("uniform-rope stretcher"), *Sulba vid* ("the expert in the *Sulba*") and *Sulba-pariprechaka* ("the inquirer into the *Sulba*")¹ Of these, one term, viz., *sama-sūtra-nirañchaka*, perhaps deserves more particular notice For we find an almost identical term, *harpedonaptæ* ("rope stretcher"), appearing in the writings of the Greek Democritus (c 410 B C) It seems to be an instance of Hindu influence on Greek geometry For the idea in that Greek term is neither of the Greeks nor of their acknowledged teachers in the science of geometry, the Egyptians, but it is characteristically of Hindu origin In the Pāli literature, we find the terms *rajjaka* and *raju-grāhaka* ("rope-holder") for the king's land surveyor² The first of these terms appears copiously, in its various case endings, in the inscriptions of the Emperor Aśoka (250 B C) In the comparatively later *Silpa śāstras*, the surveyor is spoken of as *sūtra-grāhī* or *sūtra-dhāra* ("rope-holder") and he is further described as an expert in alignment (*rekhā-jña*, lit "one who knows the line")

¹ *KS*, p 2

² *Jātaka*, edited by Fausboll, II, p 367

CHAPTER II

COMMENTATORS

There are now available several commentaries on the *Sulbas*. The more important manuals are found to have been commented upon by more than one writer. Thus we have two commentaries on the *Sulba* of Baudhayana. One of them is by Dvarakanatha Jayva and is named *Sulba dipika* (The Light of the *Sulba*). The other called *Sulba mimamsa* (The investigation into the *Sulba*) is by Venkatesvara Diksita. On the *Āpastamba Sulba* there are as many as four well known commentaries. (1) *Sulba vyakhya* (The Explanation of the *Sulba*) by Kapardisvami. (2) *Sulba pradipika* (The Light of the *Sulba*) by Karavindasvami. (3) *Sulba pradipa* (The Light of the *Sulba*) by Sundararaja and (4) *Āpastambiya Sulba bhasya* (The commentary on the *Sulba* of *Āpastamba*) by Gopala son of Gargya Nrsimha Somasuta. Sundararaja's work is also called *Sundara rajya* (The work of Sundararaja) after the name of the author as is usual in Sanskrit. I have come across two commentaries on the *Katyayana Sulba* namely *Sulba sutra vṛtti* (The Explanation of the *Sulba sutra*) of Rama or Ramacandra son of Suryadasa and *Sulba sutra vivarana* (The Exposition of the *Sulba sutra*) by Mahidhara.

The dates of most of the commentators of the *Sulbas* more particularly of the notable ones have not as yet been ascertained even approximately. Nor is it easy to do so. The periods to which some of them can be assigned from the reference by them to anterior writers and from the reference to them by writers posterior lie within such

widely varying limits as to be of no tangible value. We shall begin here with the notice of those commentators whose times are known either definitely or very nearly so.

We find from the colophon that Mahīdhara completed his commentary on the *Kātyāyana Sulba* in the Samvat year 1646 (=1589 A. D.), at Benares. It is also stated there that that commentary is based on the *Sulba-sūtra-vṛtti* of Rāma. Mahīdhara wrote as many as seventeen works on various subjects. His *Mantramahodadhī* was completed in 1589 A. D. and *Viṣṇubhakti-Kalpalatā-prakāśa* in 1597.

The commentator Rāma was an inhabitant of Naimiśa (near modern Lucknow). He seems to have been the author of several works such as *Karma-dīpikā*, *Kundākr̥ti* (with commentary), *Sulba-vārttika*, *Sāṅkhyāyana Grhyapaddhati*, *Samara-sāra* and its commentary, *Samara-sāra-saṃgraha* and the commentaries on the *Kātyāyana Sulba* and *Sārādā-tilaka Tantra*. The date of composition of the *Kundākr̥ti* is given as 1506 Vikrama Samvat (1449 A. D.). In his commentary on the *Kātyāyana Sulba*, Rāma has quoted copiously from his *Sulba-vārttika* ("The Critical Annotation of the *Sulba* ") and also from his commentary on the *Sārādā-tilaka*. There is also a quotation from the *Trisatikā* of Śrīdhara (c. 750 A. D.)¹ In this work we notice some new contributions from him. To construct a right-angled triangle having a given leg (a), Rāma suggests the employment of a new rational rectangle (a , $8a/15$, $17a/15$) in addition to those taught in the *Sulbas*² But the most notable contribution of him is a correction to the well-known *Sulba* value of $\sqrt{2}$, viz.,

$$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3 \cdot 4} - \frac{1}{3 \cdot 4 \cdot 34} \quad (1)$$

¹ KŚI, 1 30 (com). The quoted passage is the Rule 47 of the *Trisatikā* of Śrīdhara, but there is no mention of any name.

² KŚI, 1 15 (com).

Rama shows that a more accurate (*suksmatara*) value will be given by ¹

$$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3 \cdot 4} - \frac{1}{3 \cdot 4 \cdot 31} - \frac{1}{3 \cdot 4 \cdot 34 \cdot 33} + \frac{1}{3 \cdot 4 \cdot 34 \cdot 31} \quad (2)$$

Turned into decimal fraction the expression (1) gives $\sqrt{2} = 1.4142156863$ and (2) yields $\sqrt{2} = 1.41421302$. According to modern calculation $\sqrt{2} \approx 1.41421356$. So that Rama's value for $\sqrt{2}$ is correct up to seven places of decimals whereas the *Sulba* value is up to five places.

It should perhaps be noted that for certain inconsistency with the *Srauta sutra* of Katyayana Rama suspects that the *Sulba* attributed to Katyayana might be written by a different person. But the inconsistency is so minor that we cannot subscribe to the opinion of Rama in this matter. It can be reasonably explained in other ways.

Sivadasa son of Narada a resident of the city of Benares wrote a commentary on the *Mānava Sulba*. His younger brother Saṅkarabhatta is the commentator of *Matrajamajja Sulba*. Both the brothers quote from Rama Bjaṇḍeya who is no other than the commentator of the *Katyayana Sulba*. Sivadasa has quoted the second Bhaskara's (1150 A.D.) *Rule of Three* and also from his *Līlāvatī* by name. He must have been posterior to the celebrated Sayana (1320-1380 A.D.) whom he quotes.

Sivadasa observes

The study of the *Sulba* should be begun after having finished the study of the science of mathematics other wise there cannot be a thorough knowledge of the *Sulba*.

¹ It is in 13 (com). The reason for this is stated to have been in the *Sulba-vārtikā* when the editing matter had been taken.

² Comp. of AŚ in 8 (com).

Of the known commentaries of the *Āpastamba Śulba* the earliest one is, I have good reasons to believe, that of Kapardisvāmī. This writer is known to have commented also on *Āpastamba-Śrauta-sūtra*, *Āpastamba-sūtra-paribhāsā*, *Darsāpaurṇamāsa sūtra*, *Bhāradvāja Grhya-sūtra*, etc. He is quoted by Śūlapāṇi, Hemādri, Nīlakantha and others. Now Śūlapāṇi lived near about 1150 A D. He was the teacher of the famous Sadguruśiṣya (1143-1193 A D), the author of the *Vedārthadīpikā*. Hemādri was the minister of King Mahādeva (1260-71) of Devagiri and of his nephew and successor Rāmachandra (1271-1309). So Kapardisvāmī lived before the twelfth century of the Christian era. He has generalised a method taught in the *Śulbas* for finding the rational right-angled triangles having a given leg. He says

“ The added portion is divided into as many parts as the number obtained by dividing the (given) leg with the added portion by half the added portion, (put) the *nirañchana* mark by diminishing the added portion by one part ”

Let a be the given leg and suppose it to be increased by adding a portion a/m , where m is any rational integer. Dividing the increased length by half the increment, we get

$$\left(a + \frac{a}{m} \right) - \frac{a}{2m} = 2(m+1)$$

So that the added portion a/m shall have to be divided into $2(m+1)$ parts. Then the *nirañchana* mark is to be made at a distance

$$\frac{a}{m} - \frac{a}{m} - 2(m+1) = \frac{a}{m} - \frac{a}{2m(m+1)} = \frac{(2m+1)a}{2m(m+1)}$$

So that

$$a^2 + \left(\frac{2m+1}{2m^2+2m} \right)^2 a^2 = \left(\frac{2m^2+2m+1}{2m^2+2m} \right)^2 a^2$$

This method is equally available even when m is a rational fraction that is when the given leg is increased also by a multiple of it instead of by only a sub multiple of it. But this further generalisation seems to have escaped the notice of Kapardīsvami. At any rate his statement does not expressly show that he meant both the cases by his generalisation. Karavindasvami is however very explicit to leave no doubt in our mind in this respect.

He says ¹

In case of all additions as many times the added portion as the sum of the given side and the added portion is into twice so many parts the added portion is divided make the mark there (i.e. in the added portion at a distance) less by one such part. For instance in case of adding to the given side its half (consider) that half as one part the given side contains two such parts. So the given side with its increment contains three parts like the increment. Dividing the added portion into twice as many parts that mark will be (at a distance) less by one sixth the added portion. So in case of increasing the given side by itself the increment is one part the given side has one part like it. So the given side with its increment has two parts. On dividing the increment into twice as many parts it will be divided into four parts then the mark will be (at a distance) less by the fourth part. Similarly in case of adding the third part the added portion is one part the given side contains three such parts. On dividing the added portion into twice as many parts the mark will be (at a distance) less by its one eighth part. In the same way in case of adding the fourth and other parts the sum of the given side and its increment should be divided into parts in the same way and the mark should be made (at a distance) less by one such

¹ *ĀpŚ!* 2 (c n)

part Now, when the increment happens to be equal to the given side, how is then the given side to be divided? How also the mark (should be made)? How also in the case when the increment happens to be greater (than the given side)? There also the method is exactly the same, we say But the given side with its increment should then be reduced to common denominators, the added portion should then be divided into twice the number of parts (thus obtained) and the mark should be made in it (at a distance) less by one such part For instance, in case of adding twice as much, the increment is one part and (in terms of it) the given side is a half part Then on adding together the increment and the given side after reduction to common denominators, there will be three halves On dividing the increment into twice that number of parts, there will be six halves in the denominator, so the mark will be (at a distance) less by one of these parts In case of adding three times, the increment is one part, the given side is the third part (of that), there the increment contains three third parts So the given side and the increment together contain four third parts On dividing the increment into twice as many parts there will be eight third parts in the denominator Then the mark will be (at a distance) less by one of these parts In the cases of adding four times, etc, the divisions and the marks should be made in the same way "

Let a be the given side, let it be increased by its m th part

$$\left(a + \frac{a}{m}\right) - \frac{a}{m} = m + 1$$

Then
$$\frac{a}{m} - 2(m + 1) = \frac{a}{2m(m + 1)}$$

$$a + \frac{a}{2m(m + 1)} = \left(\frac{2m^2 + 2m + 1}{2m^2 + 2m}\right) a$$

$$\frac{a}{m} - \frac{a}{2m(m+1)} = \left(\frac{2m+1}{2m+2m} \right) a$$

So it follows

$$a^2 + \left(\frac{2m+1}{2m^2+2m} \right)^2 a^2 = \left(\frac{2m^2+2m+1}{2m^2+2m} \right)^2 a^2 \quad (1)$$

Or let the given side a be increased n times it

$$(a+na) - na = \frac{n+1}{n}$$

$$na - 2 \left(\frac{n+1}{n} \right) = \frac{n}{2n+2}$$

$$a + \frac{n^2 a}{2n+2} = \left(\frac{n+2n+2}{2n+2} \right) a$$

$$na - \frac{n^2 a}{2n+2} = \left(\frac{n+2n}{2n+2} \right) a$$

So it follows

$$a^2 + \left(\frac{n^2+2n}{2n+2} \right)^2 a^2 = \left(\frac{n^2+2n+2}{2n+2} \right)^2 a^2 \quad ()$$

The two results can be combined into one

$$a^2 + \left(\frac{r^2+2r}{2r+2} \right)^2 a^2 = \left(\frac{r^2+2r+2}{2r+2} \right)^2 a^2$$

where r is any rational number integral or fractional

Karavindasvami indeed wrote a commentary on the whole of the *Srauta sutra* of Āpastamba. He is known to be the author of a few other works also. His time is still very uncertain. He is found to have quoted without any mention of name certain passages from the *Āryabhatīya* (499 A D) of Āryabhata I (born 476) ¹. So he

¹ *ApSt* : 5 (m) th r f re s to th *Āy bh t y* : 9

undoubtedly flourished after the fifth century of the Christian era. Though we are not in a position to fix or even suggest any closer upper limit to his time, this limit seems to us to be too earlier. There is, however, one passage in his commentary on the *Āpastamba Sulba* which might lead one to take him as belonging to a very early age. He has referred to a certain treatise on mathematics which gives an incorrect formula for the calculation of the area of a segment of a circle.¹

$$\text{Area of a segment} = \frac{\text{arc}}{2} \times \frac{\text{arrow}}{2}$$

This formula is not found in any known treatise on Hindu mathematics and we further know that from the time of Śrīdhara (c. 750), the Hindu mathematicians used a more approximate formula for the calculation of the area of the segment of a circle. Does it then follow that Karavīndasvāmī lived in an age before the time of the discovery of that formula, that is, before 750 A.D.? It may be noted that the other formulæ in connexion with the mensuration of the segment of a circle have been stated as correctly as we find in the works of Brahmagupta (628) and other early Hindu mathematicians.

We are equally uncertain about the time of Sundararāja. This much we are sure that he lived before the fourth quarter of the sixteenth century of the Christian era. For it appears from the post-colophon that the copy of the manuscript of his commentary on the *Āpastamba Sulba* now in the possession of the State Library of

¹ “शराद्धं प्रमाणेन धनुरद्धं मथ्यस्य धनुषो फलावगम इत्यादि गणितशास्त्रादव-
गन्तव्यमिति ।”—*ĀpŚl*, III 5 (com.)

But on a different occasion (*ĀpŚl*, VII 14 15, com.), he says

“शराहतं तु कोट्यन्तदलितो धनुष फलम् ।”

This indeed gives accurately the area of the sector of the circle

Tanjore (No 9160) was made in Samvat 1638 (=1581 A D) and that in the Government Collection of the Asiatic Society of Bengal in Samvat 1640 (=1588 A D) Sundararaja is found to have quoted from Dvarakanatha Yajva's commentary on the *Baudhayana Sulba* a few passages dealing with the transformation of a square into a rectangle having a given side the correction to the *Sulba* formula for squaring the circle and *vice versa* enlargement of an altar and certain other matters

Dvarakanatha must be posterior to Āryabhaṭa I (490) whom he quotes ¹ He proves with the help of illustrative examples that the methods taught in the *Sulbas* for the squaring of a circle and *vice versa* do not lead to an accurate result as compared with that obtained by the method of Āryabhaṭa If $2a$ be the side of the square equivalent to the circle of radius r then according to the *Sulba*

$$r = a + \frac{a}{3}(\sqrt{2}-1)$$

$$a = r - \frac{r}{8} + \frac{r}{829} - \frac{r}{8296} + \frac{r}{8968}$$

These lead to $\pi = 3.0883$ 3.0885 respectively
Dvarakanatha Yajva emends them to ²

$$r = \left\{ a + \frac{a}{3}(\sqrt{2}-1) \right\} \left(1 - \frac{1}{118} \right)$$

$$a = \left(r - \frac{r}{8} + \frac{r}{89} - \frac{r}{8296} + \frac{r}{8968} \right) \left(1 + \frac{1}{118} \right)$$

These will work out $r = 3.141109$ 3.15991

¹ B⁶ 1. 60 (m) the quoted passage are Āryabhaṭa's 10
² B⁶ 1. 60 (com)

Dvāikanātha Yajvā states that

$$\frac{10}{\sqrt{3}} \text{ angulis} = 5 \text{ angulis } 27\frac{1}{2} \text{ tilas,}$$

$$\frac{12}{\sqrt{3}} \text{ angulis} = 6 \text{ angulis } 32 \text{ tilas,}$$

$$\frac{15}{\sqrt{3}} \text{ angulis} = 8 \text{ angulis } 23 \text{ tilas}$$

From these we get

$$\frac{1}{\sqrt{3}} = 580 \quad , \quad 5784313725 \quad , \quad 5784313729$$

According to modern calculation $1/\sqrt{3} = 5773$

It should be noted that there were also other commentators of the *Sulbas* anterior to those who are known to us now Kapardisvāmī, the earliest known commentator of the *Āpastamba Sulba* has referred to at least one such anterior commentator ¹

¹ “ केचिदत्र सहशब्दश्रवणादतिशयलतीयेनेति वक्ष्यन्ति चैवसमत्वाय, तदनिश्चितमिति वाचार्थस्याङ्गव्यायामेनेति वदत । ” *ĀpŚl*, vii 10 (com)

CHAPTER III

GROWTH AND DEVELOPMENT OF THE ŚULBA

It has already been observed that the science of geometry originated in India in connexion with the construction of the altars for the Vedic sacrifices. We now propose to treat this point more fully. We shall further trace as far as possible the growth and development of the Hindu Geometry from its earliest state down to the one in which we find it now in the *Sulba*. Much has been done before in this respect by Burk in his masterly introduction to his edition of the *Āpastamba Sulba*.¹ Much more still remains to be done.

The Vedic sacrifices are mainly of two classes *Nitya* (or indispensable obligatory) and *kāmya* (optional intentional). The performance of the sacrifices of the former class is obligatory upon every Vedic Hindu. It will be a sin for him if he does not do them. But it is not so with the sacrifices of the second kind. For they are to be performed each with the sole motive of achieving a special object. Those who do not aim at the attainment of any such object need not perform any of them.

According to the strict injunctions of the *Hindu Śastra* (or Holy Scriptures) each sacrifice must be made in an altar of prescribed shape and size. It is stated that even a slight irregularity and variation in the form and size of the altar will nullify the object of the whole ritual and may even lead to an adverse effect. So the greatest care has to be taken to have the right shape and size of the altar.

¹ *Āpastamba Sulba* translated with introduction by Albert Burk. ZD IG LV and LVI.

There are multitudes of the altars. Of the *Nitya* (of "the altars for the obligatory sacrifices"), the three primary ones are the *Gārhapatya*, *Āhavanīya* and *Dakṣina*. Every Vedic Hindu has to offer sacrifices in them daily. Other obligatory sacrifices are seasonal and are performed at special periods. According to the nature of the oblations they are broadly subdivided into three groups: (1) *Isti Yajña* ("sacrifice with oblations of butter, fruit, etc.") such as *Śrāddha* and *Paunnamāsa* sacrifices which are performed at every new moon and full-moon respectively, (2) *Pasuyajña* (or "Animal sacrifice") such as *Nirūdhapaśubandha* which must be performed once every year, more particularly, on a new-moon or full moon day in the rainy season, or according to a different school twice every year at the time of the winter and summer solstices, (3) *Soma yajña* ("Soma sacrifice"). This last sacrifice is very big and expensive and so cannot be performed often. But it must be performed in a family of Vedic Hindus at least once in three generations.

Now we find it from the *Śulba*, that the altar of the *Gārhapatya* must be of the form of a square, according to one school, and a circle, according to a different school. The altar for the *Āhavanīya* should be always square and that of the *Dakṣina* semi-circular. The area of each, however, must be the same and equal to one square *vyāma* (1 *vyāma* = 96 *angulis*). So the construction of these three altars, it will easily be recognised, pre-supposes the knowledge of the following geometrical operations —

- (i) To construct a square on a given straight line
- (ii) To circle a square and *vice versa*
- (iii) To double a circle

The last problem is the same as to evaluate the surd $\sqrt{2}$. Or it may be considered as a case of doubling a

square and then circling it. So in that case we get at the proposition —

(iv) The area of the square on the diagonal of a square is double the area of that square

The *Saumili vedi* or *Maha vedi* is described as an isosceles trapezium whose face is 24 padas (or prakramas) base 30 padas and altitude 36 pada. The *Sautramani vedi* is stated to be an isosceles trapezium similar to and with an area one third that of the *Maha vedi* and the *Paṭṭi vedi* is one ninth of the latter. The *Pragvanta* is a rectangle. These and other similar altars lead to the operations

(v) To construct a rectangle having given sides

(vi) To construct an isosceles trapezium whose face base and altitude are given

(vii) To find the area of an isosceles trapezium

(viii) To construct an isosceles trapezium whose area will be equal to a simple multiple or sub multiple of and which will be similar to another isosceles trapezium

Geometrical operations of more complex nature are required for the accurate construction of the *Kamya Agni* (or the fire altars for the sacrifices to achieve special objects). Amongst them the most ancient and primitive form is the *Syena* it (or the altar of the form

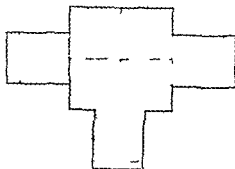


FIG 1

of the falcon ") The *ātman* (or "body," "trunk ") of this *citi* (or "altar ") consists of four squares of one square purusa each. Each of its wings is a rectangle of one purusa by one purusa and one *aratni* ($= \frac{1}{5}$ of a purusa). Its tail is a rectangle of one purusa by one purusa and a *prādeśa* ($= \frac{1}{10}$ of a purusa). This altar is more usually called *Saptavidha-sāratni-prādeśa-caturasra śyena-cit* because its area is $7\frac{1}{2}$ square purusas, its shape resembles that of a falcon (*śyena*) and because the bricks used in its construction are square.

The Fire-altars for other optional sacrifices are prescribed to be of different shapes. Thus we find altars also of the shape of (2) *vakra-paksa vyasta-puccha śyena* (or "the falcon with bent wings and outspread tail "), (3) *kanka* ("heron "), (4) *alaja* (a kind of bird), (5) *prauga* ("triangle" usually an isosceles triangle), (6) *ubhayatah prauga* ("triangles on both sides," that is, a rhombus), (7) *rathacakra* ("chariot wheel "), (8) *drona* ("trough "), (9) *samuhya* ("combined "), (10) *paricāyya* ("circular "), (11) *śmaśāna* ("cemetery "), (12) *kūrma* ("tortoise "), etc. Each of these altars shall have the same area as that of the standard form of the *Śyena-cit*, that is, $7\frac{1}{2}$ square purusas.

For the accurate construction of these altars, previous knowledge of the following principal geometrical propositions will be essential besides those noted above and a few others

(ix) To construct a square equal to a simple multiple (or sub-multiple) of another square

(x) To construct a square equal to the sum or difference of two unequal squares

(xi) To transform a rectangle into a square and *vice versa*

(xii) To construct a triangle or a rhombus equal to a square

A knowledge of the following important theorem is most indispensable for the geometry of the altar construction

(xiii) The area of the square described on the diagonal of a rectangle is equal to the sum of the areas of the squares described on its two sides

Every one of the altars is constructed with five layers of bricks which together come usually up to the height of the knee ($=3^{\circ}$ *angulis*). In some cases the use of more layers of bricks is permitted with the proportional increase in the height of the altar. Now every layer it is prescribed contains a definite number of the bricks of specified shapes. For instance each layer of the square (*arhapatya*) altar is constructed with 21 bricks of square or rectangular shape and each layer of the *Caturasra Syena cit* consists of 200 square bricks. Again in the case of the altars of other optional sacrifices shape of the bricks are varied but the number of them to be employed in the construction remains the same : c. 200. Sometimes the one and the same altar is constructed in different patterns. All these have given rise to (1) the problems of the division of figures into a particular number of parts of specified shapes and also to (2) certain interesting problems of indeterminate character.

It has been stated above that a *Kamya Igni* has an area of $7\frac{1}{2}$ square purusas. That is the case only at the first construction of the altar. At its second construction the area has to be increased by one square purusa; at the third construction by two square purusas and so on until to the size of $101\frac{1}{2}$ square purusas. But the strict injunction of the scriptures is that the shape of the altar on the whole that is the relative proportion between its different constituent parts at any construction must not be altered. Thus arise the problems of constructing similar figures.

Such is, in brief, a résumé of the more salient points in the elaborate and minute in details specifications of the shape and size of the principal sacrificial altars and of the geometrical knowledge presupposed in their construction, as we find them in the extant *Sulba*. What should be particularly emphasized now is the fact that those specifications are not due to the authors of the *Sulba* themselves. They do not even pretend to make any such claim. On the other hand, they have often and then expressly admitted to have taken them from earlier works. We, in fact, find that numerous passages of *Baudhāyana* and *Āpastamba Sulba* dealing with the spatial magnitudes of sacrificial altars as well as with the methods of their construction, end with the remark *iti vijñāyate* [or "it is known," "it is recognised or prescribed (by authorities)"]¹. Sometimes *iti abhyupadiśanti* ('thus they teach')² or *iti uktam* ("it has been said"),³ is used in the same sense. It has been rightly pointed out before by Garbe⁴ that all those passages of *Āpastamba* are literal quotations from the *Taittirīya Brāhmaṇa* or from the Brāhmaṇa-like portions of the *Taittirīya Samhitā* or *Āraṇyaka*. That is exactly true also of the similar passages of *Baudhāyana*⁵. This writer is occasionally more explicit about his sources. In connexion with certain difference of opinions amongst the altar-builders about the proper size and shape of a

¹ *BSI*, i, 65, 71, 76, etc., *ĀpŚI*, iv 1, 3, 5, v 1, 8, 10, etc.

² *BSI*, i 85

³ *ApŚI*, ix 2

⁴ Vide the Preface (p xviii) to his edition of the *Śrauta Sūtra of Āpastamba*, Vol. III, Calcutta, 1902. Garbe has pointed out in a most scholarly manner the relations of this work with others such as *Samhitā*, *Brāhmaṇa* and *Śrauta sūtra*.

⁵ Compare for instance the passages with such remarks in *BSr*, xxiv 2 with *TS*, i 2 2 3, *BSr*, xxiv 29 = *TS*, i 7 3 1, *BSr*, xvi 21 = *TS*, vii 1 2 3, *PañBr*, xxiii 19 8, etc.

particular altar ¹ Baudhayana is found appealing to the authorities of the *Brahmana* by name for the purpose of arriving at a satisfactory settlement. This is not right observes he as it will bring this opinion in contradiction with the ancient precepts. Regarding this point the *Brahmana* of some is as follows of others is. And the following is our *Brahmana*. By our *Brahmana* is meant the *Taittiriya Samhita* where indeed the quoted passage occurs ³. On a different occasion in connexion with certain method of constructing a particular altar Baudhayana remarks. There is also a *Brahmana* on this point ⁴. Here again the reference is to the *Taittiriya Samhita*. There are also other mentions of *Brahmana* in general by Baudhayana ⁵. He has once quoted the *Maitrayaniya Brahmana* by name ⁷. Katyayana is found to have appealed similarly to the authority of the *Śruti* on two occasions ⁸. Apastamba has sometimes observed that certain constructions are not sanctioned by the *Śruti* ⁹. Thereby he clearly implies that other matters about the spatial magnitudes of the sacrificial altars and the methods of constructing them that have been recorded by him are in full accordance with the teachings of the *Śruti* but are not his devices. This he has admitted

¹ The too easy ground that it is the first shaped alt. for a 1½ to 6½ q. apru. tho. with two ad. t. l. Th. will be left with me fully l. t. Comp. *ĀpŚl* v. 35

² *BSl* 159

³ *TS* v. 5.1

⁴ *BSl* 35

⁵ *TS* 6.6.3

⁶ *BSl* 6. Hr. th. f. ne. to *TS* 3.1.5. s. d. v. 5.3
Comp. r. l. o. *BSl* 1. with *TS* 4.11.1

⁷ *BSl* 10

⁸ *KŚl* 7. vi. 4

⁹ *ĀpŚl* viii. 6.6

also otherwise, as has been just pointed out. It will be further shown presently that we can, indeed, trace most of the matters contained in the *Sulba* to the earlier *Bṛāhmaṇa* and *Samhitā*.

The reference to the sacrificial altars and their construction is found as early as the *R̥g-veda Samhitā* (before 3000 B C) ¹. There is mention in that work of the "three places" of the Agni, ² which doubtless imply the *Gārhapatya*, ³ *Āhavanīya* and *Dakṣināgni*. Though we do not find there any specific mention about the relative sizes and shapes of these altars we have nothing to doubt that they were, in any way, different from what we meet with in posterior *Bṛāhmaṇa* ⁴. Hence it seems that the problem of the squaring of the circle and the theorem of the square of the hypotenuse (at least in its simplest form) are as old in India as the time of the *R̥g-veda*. They might be older still. For it has been shown by Oldenberg that those three fires are earlier than the *R̥g-veda* ⁵.

In the *R̥g-veda*, it should be made clear, there is no particular rule for the construction of the altars. We cannot indeed reasonably expect to find such a rule there,

¹ There are innumerable references in the *R̥g-veda* to the sacrifice altars and their constructions. For the mention of the *vedi*, see for instance *RV*, i 164 35, i 170 4, v 31 12, vii 35 7, etc., and for its construction compare the passages "O Lovely (Agni)! They construct the *vedi* for you and offer oblations there" (*RV*, viii 19 18), "measured out the *vedi*" (*RV*, x 61 2), etc.

² "यज्ञस्य केतुं प्रथमं पुरोहितमग्निं विषधस्यै समिधीरे," *RV*, v 11 2.

³ The mention of the *Gārhapatya* Fire by name occurs, for instance, in *RV*, i 15 12, vi 15 19 and x 85 27.

⁴ The first express description of the *Gārhapatya* as a circle of one square *vyāma* (= *purusa*) and of the *Āhavanīya* being a square of the same size appears in the *Satapatha Brāhmaṇa* (vii 1 1 37, vii 2 2 1 ff. Cf. *SBE*, Vol XL, iii, p 307, fn 2). In the *Taittirīya Samhitā* (v 2 5 1), the *Āhavanīya* is stated to be of one (square) *purusa*.

⁵ Oldenberg, *Religion des Veda*, p 348, n 2, *SBE*, Vol. XXX, p 1x.

One thing should be made here perfectly clear the treatment in the earlier literatures the *Samhita* as well as the *Brahmana* of the measurement of the various *Veda* and *Yajur* appertains chiefly to the ritualistic aspects of the problems. Reference to the secular or geometrical and other truly scientific aspects are only incidental for them and hence are found on rare occasions. Fuller details of the geometry of the measurements of the altars are particularly described in the *Sulba* parts of the *Srauta sutra*. But traces of that it will be shown conclusively in the course of this work are clearly noticeable also in the *Brahmana*. And it will not be improper I think to presume that the geometrical methods for the solution of the problems of the measurements of the altars were known in still earlier periods. For the rituals of measurements will be altogether baseless unless accompanied by a knowledge of the underlying geometry. In the *Taittiriya Samhita* we find the following scanty reference to the scientific operations for the construction of the *Darsapurna* *masikavedi*.

He performs the second drawing of a boundary himself. The earth is of the size of the altar. Verily having excluded his enemy from so much of it he performs the second drawing of the boundary himself. Cruelly he acts in making an altar.

But such measurements and descriptions of course do not help us in any way to conjecture the geometrical devices adopted for the construction.

We shall now proceed to show as briefly as possible that some of the specifications about the shape and size of the various *Veda* and *Yajur* and about their relative positions which we find in the *Sulba* can be clearly traced.

to earlier *Samhitā* and *Brāhmaṇa*. This will doubtless corroborate the traditional origin of the science of Hindu Geometry in a very remote age to be true. We have already shown the ancient origin of the three fundamental altars, the *Gārhapatya*, *Āhavanīya* and *Dakṣināgni*. Their relative positions are described in the *Satapatha Brāhmaṇa*¹ and *Srauta-sūtra*² to be identical. According to all the *Samhitā*³ and *Brāhmaṇa*,⁴ as in the *Sulba*, the *Gārhapatya citi* must be constructed with the same number of bricks, namely 21, arranged in an identical manner. It is further stated in the *Taittirīya Samhitā*

“He who constructs (the *Gārhapatya citi*) for the first time should construct in five layers. He who constructs for a third time should construct in one layer.”

The spatial magnitudes of the *Saumikī-vedi* (or “the altar of the Soma-sacrifice”), also called the *Mahā-vedi* (“the Great Altar”) which has been already described to be of the form of an isosceles trapezium whose face is 24 *prakramas* (or *padas*) long, base is 30 and altitude 36 *prakramas*, are given in the *Samhitā*,⁵ and *Satapatha Brāhmaṇa*⁷. But the earliest description of a method of its measurement, or a method for the construction of an isosceles trapezium having given face, base and altitude is found in the latter work. It says

“From that (the largest post on the east side) one proceeds three *vikramas* to the east and there fixes a pole, this

¹ *SBr*, i 7 3 23-5

² Cf. *BŚr*, *BŚl*, i 64 69, *ĀpŚr*, v 4 3 5, *ĀpŚl*, iv. 1 4, *KŚr*, iv 8 19, *KŚl*, i 26, 2 8

³ Cf. *TS*, v 2 3 4ff, *MS*, iii 2 3, *KtS*, xx 1, *KapS*, xxiii 3

⁴ *SBr*, vii 1 1 18, 33 4

⁵ *TS*, v 2 3 6f

⁶ *TS*, vi 2 4 5, *MS*, iii 8 4, *KtS*, xxv 3, *KapS*, xxviii 6

⁷ *SBr*, iii 5 1 1ff, x 2 3 4. Compare also *BŚr*, vi 22, *ĀpŚr*, xi 4 11-6, *KŚr*, viii 3, 6 12, *MāŚr*, ii 2 1 12

is the middle hind pole (*antihpatah*) From the middle hind pole he goes 10 prakramas toward the south and fixes a pole there this is the south west corner (of the Mahavedi) From the middle hind pole he proceeds 15 prakramas towards the north and fixes a pole there it is the north west corner From the middle hind pole he goes 30 prakramas towards the east and fixes a pole this is the middle front pole From the middle front pole he strides 12 prakramas towards the south and fixes a pole this is the south east corner From the middle front pole he goes 12 prakramas towards the north and fixes a pole there this is the north east corner Such is the measurement of the (*Mahavedi*)¹

Here or anywhere else in this *Brahmana* we are not taught how to draw the east-west line and how to draw a line at right angles to it (i.e. the north-south line) through a given point on it That there were some methods for these constructions is beyond question We have only to conjecture what were these methods Now almost identical descriptions about the measurement of the *Mahavedi* reappear in the *Srauta sutra* of Baudhayana and Apastamba² It has been further taught by the former writer that all the measurements are to be made by means of a cord on the principle of a rational rectangle (*vide infra*) The *Śatapatha Brahmana* is known to have measured the *vedi* with a cord³ Had it also recourse to the same method? At any rate it is not improbable For we have clear evidence to prove

¹ SB 5.1.16

² BS vi In the middle of the temple the east-west line is drawn and the north-south line is drawn at right angles to it

³ Ap. x.4.1 Corp. al. K 3.6.12 d the method of K&S just d. Yājñalk 1 mm t y th 11th S tr

⁴ Cf. SB x.3.8ff

that the theorem of the square of the diagonal, or the so called Pythagorean Theorem was known then and used to be employed in that as well as in other connexions ¹

The construction of a square having a given side is described thus (omitting the descriptions of the ceremonies and speculative explanations)

“ He then takes up the wooden pin (*śamyā*) and wooden sword (*sphya*) Then from the pole which lies in the north-east (corner of the *Mahā vedi*) strides three prakramas backwards and then marks out the pit (*cātvāla*) That is the measure of that pit, it has no other measure Wherever he himself thinks it (proper) in his mind, in front of the *utkara* (“the heap of rubbish”), there he marks out the pit He (draws first) the (western) extremity of the altar He lays out the wooden pin northwards and marks out (a line) Then on the front he lays down the wooden pin northwards and marks out (a line) Then on the southern extremity of the altar he lays down the wooden pin eastwards and marks out (a line) Then on the north he lays down the wooden pin eastwards and marks out (a line) ” ²

This is, in fact, the square pit, with the earth from which the *Uttara-vedi* is constructed Hence both have the same cubical content This measurement of the pit reappears in the *Sulba* It is, perhaps, particularly noteworthy, that in the above we find an instance of the use, in former times, of a ruler (in the body of the straight wooden pin, called the *śamyā*) to draw a straight line from a given point in a specified direction It is not said how those directions, or rather the cardinal directions passing through a point were used

¹ *Vide infra*

² *SBr*, III 5 1 26-30 Compare also *TS*, VI 2 7 1 2

to be determined Was a pair of compasses also in use then?

Though lacking description of the rites and ceremonies in connexion with the construction of the various other altar such as the *Darsāpurnamasa* i.e. *Uttara vedi*, *Aśamedha* i.e. *Ignidhriya*, *Hotriya*, *Margaliya*, *Sūdas*, *Uparavas* etc. are commonly found in the *Taittiriya* and other *Saṃhita* any clear mention of their spatial magnitudes are very rare therein In that respect we obtain much better information from the *Brahmana*

It has been stated before that the standard form of an optional Fire altar is that of a certain bird This bird is called *Syena* (falcon) in the *Taittiriya Saṃhita*¹ and *Suparna Garutman* (well winged eagle) in the *Īajasanya Saṃhita* and *Satapatha Brahmana*² which is sometimes abridged into *Suparna* in the latter³ The first name is found more commonly in other *Saṃhita* and *Srauta sūtra* whereas the other names are rarely met with elsewhere A clear reference to this form is found in the *R̥gveda* where *Agni* is frequently called a bird⁴ The spatial magnitudes of the falcon shaped Fire altar have been defined in almost all the earlier works from the *Taittiriya Saṃhita* onwards and they are exactly the same as those that are found in the *Sulba* Though it is stated by the authorities that it should be measured preferably with a bamboo rod the details of the method of

TS 7.4.11.1

2 1 5 x 4

3 SB x 4

4 SB 7 6 8

5 The n m S p t f th s t patla B l na a (2 S)
r pp th V s lb () b t t f m d f r f m t'e
ent by th dd t n of h d

6 P 1 64 5 14 5 m p r l s o : 53 5 141 7 1 4 v

3 7 4 7 8 3

measurement are scanty in earlier ones. The *Taittīyā Samhitā* says

“ With man’s measure he metes out, man is commensurate with the sacrifice, verily he metes him with a member of the sacrifice, so great is he as a man with arms extended, so much strength is there in man, verily with strength he metes him. Winged is he, for wingless he could not fly, these wings are longer by an ell (*aratni*), therefore birds have strength by their wings. The wings and the tail are a fathom (*vyāma*) in breadth, so much is the strength in man, he is commensurate in strength. He metes with a bamboo, ” ¹

The *Maitrāyaṇīya Samhitā* says

“ As much ^{po}as a man with arms extended, with so much a bamboo, and, (the Fire-altar) is meted out, so much strength is there in the man, verily with strength it is meted out, He metes out the Fire altar, seven (square) purusas he metes out, for by seven purusas he knows the universe and by seven purusas of the self he eats food. A measure of *aratni* is added to the two wings, the birds have strength by their wings ” ²

More particulars are supplied by the *Satapatha Brāhmaṇa*

“ Verily He comprises seven purusas. Seven purusas certainly are in this Person (Agni), since four (purasas) (as) the body and three the wings and tail, for the body of that Person is certainly (composed of) four (purasas) and the wings and tail of three. He metes it out with (the measure of) a man (*puruṣa*) with arms extended. Verily the sacrifice is a *puruṣa* and hence by it, all these are measured, and that is its best

¹ *TS*, v 2 5 1ff (translation by Keith)

² *MaiS*, iii 2 4

measure inasmuch as with arms extended he (man) has his maximum measure he then secures for him that and by that he measures it Then he adds two aratnis to the two wings by that he gives strength to the wings Verily the two wings are two arms (of the bird) and by arms food is eaten simply for the sake of food he makes that space inasmuch as the food is taken from the distance of an aratni the two aratnis he adds to the two wings Then to the tail he adds a vitasti He thus gives strength to the support verily the tail is the support The hand (consists of) vitastis and by means of the hand the food is eaten simply for the sake of food he makes that space Inasmuch as he adds one vitasti to the tail he settles for it the food because he adds less here (in the tail) he $\frac{1}{2}$ $\frac{1}{3}$ reby secures it in the food Thus this much is it (the body) measured and this much is it (wings and tail) certainly it (the bird or altar) is measured this much in order to secure for it that (its natural measure) ¹

Full details of the methods of measurement of the falcon shaped Fire altar are not found until the *Srauta sutra* The method of the measurement by means of a bamboo rod has been described in the *Ipastamba Sulba* and that by means of a cord is hinted in the *Baudhayana Srauta*² described in full in the *Katyayana Srauta* The latter says

Measure a cord two puru as long Make ties at its both ends Make marks at the middle on either sides of it at the halves of the purusas at distance of the one fifth of a purusa from the middle (mark) and also

SB 58 Cf 116 x 34
² 4pSl 7 x 3 Compar 14 ApS 118
³ BS x 19 : 1

at their halves (that is at one tenth purusa from the middle mark). Stretch the cord along the *prsthyā* (the east-west line) and fix poles at the two ties, the middle mark and the marks at semi-purasas. Unfasten the two ties, fasten them to the semi-purusa poles and then stretch the cord towards the south by holding it by the middle mark. Make a point at the place reached by that. Unfasten the two ties, fasten one at the middle pole, then stretch the cord towards the south over the point and fix a pole at the place reached by the middle mark. Then fasten one tie at this pole and another at the eastern pole, stretch the cord towards the south and fix a pole at the place of the middle mark, then another also at the semi-purusa mark. Unfasten the tie from the eastern pole and then fasten it to the western pole, stretch the cord southwards and fix a pole at the place reached by the middle mark and also two about it at the semi-purusa marks. Proceed in the same way on the northern side. Again on the southern side, stretching the cord in the way indicated before, fix a pole at the distance of the fifth-purusa-mark. Having fastened a tie at that, and also at the eastern semi-purusa pole, stretch the cord properly, and fix a pole at a distance of the semi-purusa-mark (from the one) and the fifth-purusa-mark (from the other). Similarly on the west. Similarly (construct) the northern wing. Thus also the tail with its *vitastā*. If desired, the two sides of each wing and of the tail may be contracted by four *angulas* each on one extremity and extended by the same amount on the other."¹

The *Satapatha Brāhmaṇa*, however, teaches us how to bend the wings of the falcon in order to construct that

variety of the Fire altar known as the *Valrapasa Syenaciti*

He contracts the inner extremity (of the southern wing) inside on both sides only by four angulis by four angulis outwards on both sides he expands the outer extremity Thus by as much he contracts by so much he expands certainly for that he neither exceeds (the proper size of the wing) nor makes it too small Similarly he does for the tail and in the same way for the northern wing. Then he makes the bent of the two wings For bents there are in the wings of a bird the bents of the wings of a bird are by its one third each by one third of the wings inwards each the bents of the wings of the bird are He expands (each of the wings) on the front just by four angulis he contracts at the back by four angulis Thus by as much he expands by so much he contracts and so he neither exceeds nor makes it too small ¹

A complete list of the various *hamya Agni* together with a statement of the objects for the attainment of which each of them is to be constructed and sacrifices made therein is found in the *Taittiriya Samhita* ² That has been practically reproduced in the *Baudhayana Śrauta Sūtra* The enumeration of most of them appears in the *Matraya ya Samhita* ⁴ and *Satapatha Brāhmaṇa* It may be noted though it is immaterial for our purpose that the construction of Fire altars other than the *Suparna citi* (the eagle shaped altar) is forbidden in the latter work

¹ QB 1 4 mp e 1 o SB 1 7 BM 6 B

² TS 4 11

³ BS 2 8 30

M S vi 4 7 Cf II

⁵ SB 7 6

Thus we find that almost all the *Vedi* and *Agni* which are described in the *Sulba* can be traced back, for the matter of their shapes and sizes, as far as the time of the *Brāhmaṇa* (c 2000 B C), and they are mentioned even in the *Samhitā* (c 3000 B C). The *Sulba* has, in fact, expressly admitted in the majority of cases, as has been pointed out before, that it has taken the spatial magnitudes of the altars from the earlier literatures. We can, similarly, trace the earlier origin of many other matters traced in the *Sulba*. As regards the height of an *Agni* and the number of bricks to be used in its construction, *Taittirīya Samhitā* observes

“ He should pile (the fire) of a thousand (bricks) when first piling (it), this world is commensurate with a thousand, verily, he conquers this world. He should pile (it) of two thousand when piling a second time, the atmosphere is commensurate with two thousand, verily, he conquers the atmosphere. He should pile (it) of three thousand when piling for the third time, yonder world is commensurate with three thousand, verily, he conquers yonder world. Knee-deep should he pile (it), when piling for the first time, verily, with the *Gāyatrī* he mounts this world, navel-deep should he pile (it) when piling for the second time, verily with the *Tristubh* he mounts the atmosphere, neck-deep should he pile (it) when piling for the third time, verily, with the *Jagatī* he mounts yonder world ”¹

Each *Agni* is usually constructed in five layers, when constructed for the first time. It should have double or treble number of layers when constructed for the second or third time. The *Taittirīya Samhitā* says —

¹ TS, v 6 8 2 f (Keith's translation)

The first layer is this (earth) the mortar the plants and trees the second is the atmosphere the mortar the birds the third is yonder (sky), the mortar the Nakṣatras the fourth the sacrifice the mortar the sacrificial fee the fifth the sacrificer the mortar the offspring if he were to pile it with three layers he would obstruct the sacrifice the fee the self the offspring therefore should it be piled with five layers verily he preserves all In that there are three layers (it is) since Aṁṁ is of threefold in that there are two (more) the sacrificer has two feet (it is) for support there are five layers man is five fold verily he preserves himself There are five layers he covers (them) with five (sets of) mortar these make up ten man has ten elements he preserves man in his full extent ¹

But when *Nalasaḥ* and *Pañcasodā* bricks are employed after the fourth layer there will be a sixth layer as the height of these bricks are half the usual height of a brick viz. the one fifth of a *janu* (=32 angulis) This sixth layer is mentioned also in the *Taittiriya Samhita*

The growth and development of (1) the theorem of the square of the diagonal () the quadrature of a circle and (2) the construction of similar figures has been treated elsewhere in their proper places We have clear proofs it has been shown there of the use of these in the time of the *Satapatha Brāhmaṇa* (c. 2000 B.C.) The first two seem to be still older But we do not find an enunciation of the theorem of the square of the diagonal and a method for the quadrature of the circle before the time of the *Srauta sūtra* A method for the construction of similar figures is taught in the *Satapatha Brāhmaṇa* and it is the same as we find in later works

¹ *Ib id* 6.10.1 (K th) Comp BSI : 13

² *Ib id* 6.10.3 Comp BSI : 18.59

CHAPTER IV

POSTULATES

For the geometrical operations described in the *Sulba*, the authors, we find, have tacitly assumed the truth of certain other results without any attempt to describe them beforehand or to indicate how they could be effected. These results we have called here postulates of the *Sulba*. They might not be postulates in the Euclidean sense of the term, but they can certainly be so called in accordance with the meaning given by Aristotle, namely "whatever is assumed, though it is a matter for proof, and used without being proved." Most of the postulates of the *Sulba* are concerning the division of figures, such as straight lines, rectangles, circles and triangles. A few of them are about other matters of importance.

(a) *A given finite straight line can be divided into any number of equal parts*

In the geometry of the *Sulba*, it is oftentimes required to divide a given finite straight line into a specified number of equal parts. For example in one instance, the diameter of a given circle is divided into 8 equal parts, each of these again into 29 parts and so on into other number of divisions.¹ There are indeed numerous such instances.² Now it will be naturally asked how it was used to be done. Certainly not arithmetically. At least it is not always possible to do so. For we find instances of division of straight lines which cannot be expressed in terms of commensurate numbers. In circling a square, such a straight line has

¹ *BSI*, I 59

² *BSI*, I 60, 68 9, etc

to be divided into three parts¹ and in another case into twelve parts² Sometimes the given straight line is such that the parts when expressed arithmetically will contain big fractions Thus the side of a square of 96 *angulas* has to be divided into 7 equal parts³

(b) A circle can be divided into any number of parts by drawing diameters

In the *Sulba* we have several instances of the division of a circle into a specified number of parts For instance it is said that the *Dhisniya* may be square or circular in shape and one of them viz the *Agnidhriya* has to be divided into nine parts Now in the case of the square shape of the altar it is easily divided into 9 smaller squares by drawing cross lines through the points of trisection of the sides When it is circular there is described a small circle about its centre and the annulus

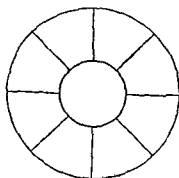


Fig 2

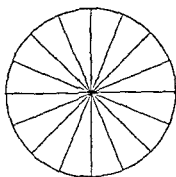


Fig 3

is then divided into 8 equal parts by drawing four diameters⁴ Similarly in an alternative circular shape of

BSI 56

¹ BSI 162 mp lso ApSI s 7 in which the d 1 f
q f de = 4 f pu a d d d to q l p r t

³ BSI 64

⁴ BSI 73 4 ApSI 13 14

the *Mārjāliya* fire, the circle has to be divided into 6 equal parts ¹ A circular annulus has been divided into 32 equal parts,² another annulus into 64 equal parts and then again into two parts each by, drawing the mean circle ³

(c) *Each diagonal of a rectangle bisects it*

(d) *The diagonals of a rectangle bisect one another and they divide the rectangle into four parts two and two vertically opposite of which are equal in all respects*

The description of the division of a rectangle or a square by diagonals is found in the *Sulba* primarily in

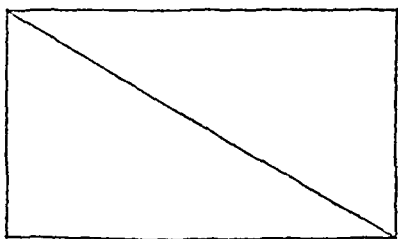


Fig 4

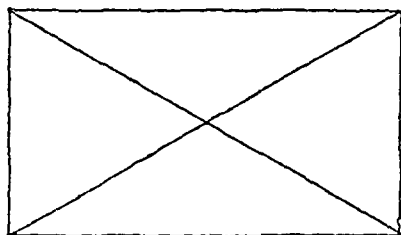


Fig 5

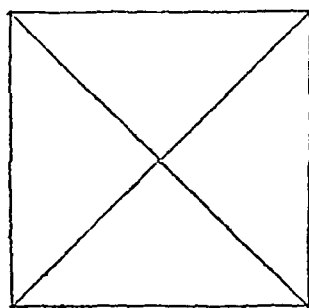


Fig 6

¹ *BŚI*, II 77 Compare *ĀpŚI*, XVII 21 3, 4 for instances of division of a circle into 12, 16 and 24 parts

² *BŚI*, III 200

³ *BŚI*, III 202

connexion with the making of bricks of desired size and shape. Certain interesting geometrical theorems have been assumed there. The brick which resembles in shape the portion of a rectangle or of a square divided by its diagonal is termed *ardhya* (or the half) and that resembling a portion by the two diagonals is called *padja* (or the quarter). There are distinguished two kinds of *padya* of a rectangle viz *dirgha padya* (or longish or broader quarter) and *śula padya* (or trident quarter).¹ This distinctive nomenclature implies (1) the halves of a rectangle or of a square by a diagonal are identical in size as well as in shape and (2) so are also the quarters of a square by its diagonals and (3) the diagonals of a rectangle divide it into four parts which are equal in area but they are of two kinds as regards their shape. These names perhaps further imply an idea of *obtuse* and *acute* angles. There are bricks which are halves of the quarter bricks by the perpendicular from the vertex on the base. No distinction is found to have been made between the half of a *dirgha padja* and that of a *śula padya* which clearly shows that the *Sulba* karas were aware that those halves were identical. Thus it appears that the early Hindu geometers knew the simple cases of the congruence theorems.

Another interesting kind of bricks is formed by the combination of a half of a *dirgha padya* or a *śula padya* with another brick. Baudhayana describes

The eighth parts of them should be so combined as there will be (a brick having) three corners.²

¹ BSI II 168 9 178

² The r f ce t q r b l ll d p c m f a h d f
 at q l to the fifth (p ac m) p t of p ru d to a t l
 by l n fifth f puru by fifth f p t h f

³ BS 12.

A brick of this kind is technically called *ubhayī*¹ (from *ubhay*, "both") because it is formed by the combination of

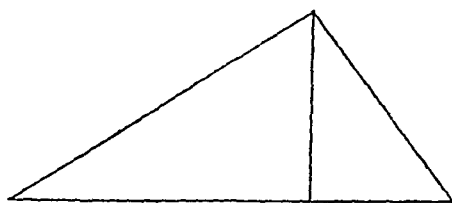


Fig 7

two bricks of two different kinds. Since there is mentioned only one *ubhayī* though there are distinguished two different kinds of quarter bricks of a rectangle (the *adhyardha*) it follows that Baudhāyana was fully aware, what has been just mentioned, that all the eighth parts of a rectangle are identical. What is much more noteworthy is that in the formation of the *ubhayī* we find the source of the discovery of the later Hindu principle of forming a rational scalene triangle by the juxtaposition of two rational right-angled triangles.²

(e) *The diagonals of a rhombus bisect each other at right angles*

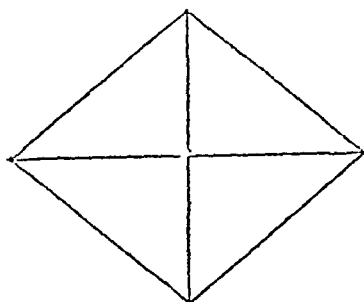


Fig 8

¹ *Ibid.*, iii 129

² Bibhutibhusan Datta, "On Mahāvīra's Solution of Rational

(f) *A triangle can be divided into a number of equal and similar parts by dividing the sides into an equal number of parts and then joining the points of division two and two*

Baudhayana on a certain occasion says this (triangle) is divided into ten parts. But how to do it he does not explain expressly. We however learn it from the commentators that the traditional practice in such a case was

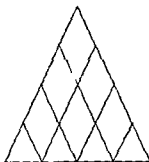


Fig 9

to divide each side into four equal parts and then to join the points of division two and two as indicated in the Fig 9

(g) *An isosceles triangle is divided into two equal halves by the line joining the vertex with the middle point of the opposite side*² Each of these has again been divided into six parts³

T 1 d Q d l t 1 B H C l Math So Vol x pp 67
34 p t l l y pp 67

¹ B d 6

I b d 58

³ I b d 60

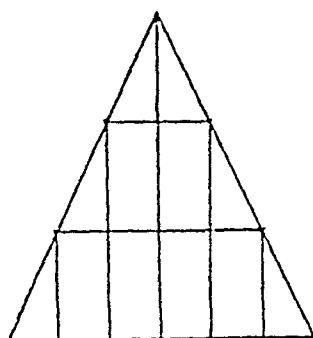


FIG 10

We shall see later on that figures of more complex shapes had to be divided into a specified number of parts, namely 200, of given forms. And this led to some interesting problems of indeterminate character

(h) *A triangle formed by joining the extremities of any side of a square to the middle point of the opposite side is equal to half the square*

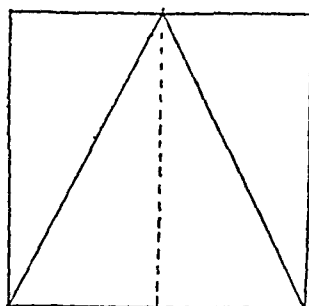


FIG 11

(i) *A quadrilateral formed by the lines joining the middle points of the sides of a square is a square whose area is half that of the original one*

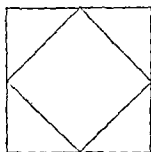


Fig 12

(i) A quadrilateral formed by the lines joining the middle points of the sides of a rectangle is a rhombus whose area is half that of the rectangle

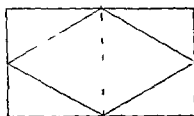


Fig 13

(ii) A parallelogram and a rectangle which are on the same base and within the same parallels are equal to one another



Fig 14

The assumption of the truth of this theorem forms the basis of the *Sulba* method of the construction of a parallelogram having given sides inclined at a given angle, which will be described later on. It was also known in the time of the *Satapatha Brāhmaṇa* ¹

(1) *The maximum square that can be described within a circle is the one which has its corners on the circumference of the circle*

In the *Sulba* it is sometimes necessary to draw within a circle "a square as large as possible (*yāvat sambhavet*)," but it is not indicated how to do it. From the subsequent descriptions it, however, appears clearly, that the corners of that square are assumed to be on the periphery of the circle. The commentators explain that a side of this square will be equal to $\sqrt{2}$ times the radius of the circle. In fact, two diameters of the circle are

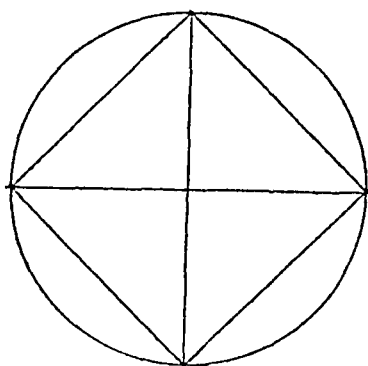


Fig 15

drawn at right angles to each other. The figure formed by joining the end points of them, is the largest possible square within the circle.

¹ X 2 1 5

² *BSI*, i 70, *ĀpŚi*, vii 10, xii 12. Compare *Pandit*, O S, X, p 166.

It will be noticed that every one of the above propositions is demonstrable. Branding of them as postulates raises the important question of the character of the early Hindu geometry as regards the matter of demonstration. Of course the propositions of the *Sulba* are not proved after the manner of Euclid by purely deductive reasoning. On the other hand it is not wholly empirical without any semblance of demonstration. In fact we find a kind of proof in case of the propositions of the subtraction of one square from or its addition with another square and the mensuration of an isosceles trapezium. After the enunciation as a general proposition of the theorem of the square of the diagonal Baudhayana observes that the truth of it will be realised in case of certain rational rectangles enumerated. This is really an attempt for a kind of demonstration. What is much more noteworthy in this connexion is the fact that after a description of the geometrical construction for a proposition the *Sulba* karas are often found to have remarked *sa samadhik* or

This is the construction.¹ The significance of such an observation is obvious. It emphasizes that the construction which was required to be made has been thus actually made and indeed corresponds to the expression *Quod Erat Faciendum* (or What it was required to do) occurring at the end of a proposition of Euclid's *Elements*. Further it discloses a rational and demonstrative attitude of the mind of the early Hindu geometer. With reference to a similar remark occurring in the works of the celebrated Hindu mathematician of the twelfth century of the Christian era Bhaskara II Haikal observed. The small word *see* along with the figures together with the necessary auxiliary lines supplies the Brahmanas with the

¹ *Āpsī* 1 *KŚī* 1 4 m 13 et

'proof of the Greeks' concluding with solemn words ' what was to be proved ' All that a practised mind could recognise by means of assiduous consideration of a figure was admitted as certain " ¹

¹ H Hankel, *Zur Geschichte der Mathematik in alterthum und mittelalter*, Leipzig, 1874, pp 205 f.

CHAPTER V

CONSTRUCTIONS

To draw a straight line at right angles to a given straight line

(a) Suppose that the given straight line runs east to west. On it fix two poles at an arbitrary distance apart says Katyayana. Then

Increase a cord of length equal to the distance between them (poles) by itself and make two ties at the ends. Then having fastened the two ties at the two poles stretch the cord by its middle point towards the south and fix a pole at the place reached by the point. Proceed similarly on the north. It (the line joining these two poles) is the north to south line.¹

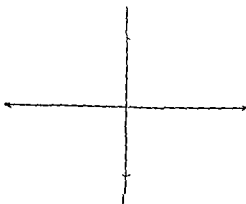


Fig 16

But the more common and at the same time the oldest Hindu method of drawing a straight line at right angles to another is as follows

(b) Take two points on the given straight line. Describe two circles with their centres at these two points and their radii equal to the distance between them. The

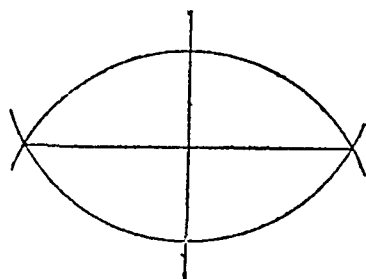


FIG 17

line joining the points of intersection of the two circles is perpendicular to the given line

To draw a straight line at right angles to a given straight line from a given point on it

It should be observed that there is no particular rule for this construction in any *Sulba-sūtra* except perhaps the *Kātyāyana Sulba Parīśista*. But it appears from the descriptions of other constructions that more than one device were used to be adopted for that purpose. The earliest of these methods is as follows

(a) Take two points (B , C) on the given straight line (BC) at equal distance from the given point (A). With centre B and radius BC describe a circle. Similarly with

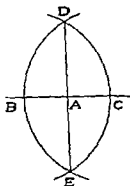


FIG 18

centre C and radius CB describe another circle. Let D and E be the points of intersection of these two circles. Join AD or AE or DE . Then this straight line will be at right angles to the given straight line BC at A .

(b) On the given straight line (BC) fix two poles (B C) equally distant from the pole at the given point A .

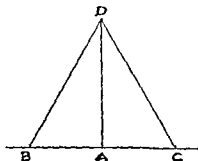


FIG 19

Take a cord twice as long as BC . Make a tie at each of its ends and a mark at the middle. Fasten the two ties at the poles B C and stretch the cord towards the side having taken it by the middle mark. Fix a pole D at the point reached by the mark. Join DA . It is the required

straight line which is at right angles to BC at the given point A

(c) Fix a pole (B) at a certain distance from the pole at the given point (A) on the given straight line (AB)

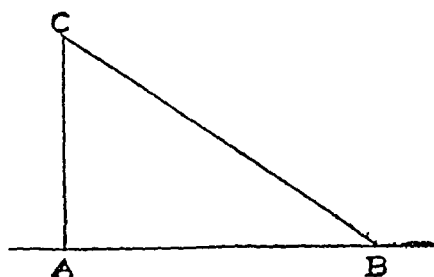


Fig. 20

Take a cord of suitable length. Make a tie at both ends and a mark at a proper point in it. Having fastened the ties at the poles (A, B), stretch the cord sideways by the mark and fix a pole (C) at the point reached by it. Then AC is the required straight line.

To construct a square having a given side

Method I

“In a bamboo-rod, make two holes (A, B) as much apart as the height of the sacrificer with uplifted arms¹ and a third hole (C) mid-way between them. Place the bamboo-rod on the east-to-west line and fix poles in the holes (beginning) from the western extremity of the sacrificial place. Then freeing the two poles (C, B) on the west, describe a circle (by rotating the bamboo) south-east-ward by the hole at the (opposite) end. Then unloosening the eastern hole and fixing the hole in the west (in

¹ The square to be constructed is to have, in the present case, a side of that length.

its original position) describe another circle south west wise by the hole at the opposite end. Now release the bamboo (completely) fix again an extreme hole at the middle pole (*C*) place it towards the south over the point of intersection of the two circles and fix a pole at the point (*F*) reached by the outermost hole. Then fix at this pole the middle hole of the bamboo and having laid it along the extreme outer edges of the two circles¹ fix two poles (*E D*) at the two (outermost) holes. It (the figure thus described *ABDE*) is a square (having a side) of one *purusa* (Fig 21)

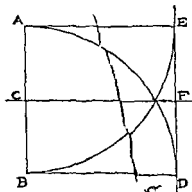


Fig 21

Method II

If you wish to construct a square take a cord as long as its side is desired to be make a tie at both ends and a mark at the middle. Then having drawn a line (east to west) of the desired length fix a pole at its middle. Fasten the two ties at this pole and describe a circle with the mark. Now fix poles at the both ends of the diameter (running east to west). Having fastened one tie at the eastern pole describe a circle with the other

¹ That is the bamboo hold both ends together at both the ends of the pole at the mark the point of contact

² ApSiv 1 (8 10) 1 (1)

tie Describe a similar circle about the western pole On joining the points of intersection of the circles, the second (i.e., north-to-south) diameter will be found Fix two poles at the extremities of this diameter Now, having fastened both ties at the eastern pole, describe a circle with the mark Similarly describe circles about the southern, western and northern poles The exterior points of intersection of these circles will determine the square''' (Fig 22)

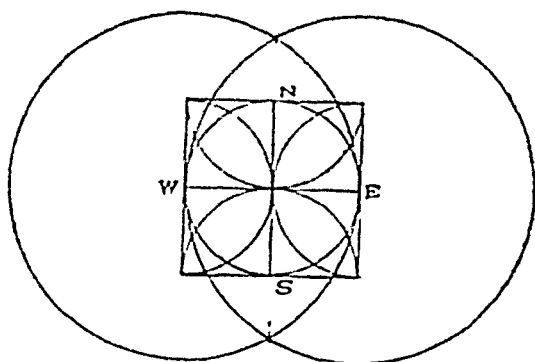


Fig 22

Method III

“ Take a cord as long as the measure (to be given to the side of the square) , make a tie at both ends and a mark at the middle of itself and of its two halves Stretch out this cord along the east-west line and fix poles at the ties and marks Then having fastened the ties at the two poles of outer marks, stretch the cord towards the south having taken it by the middle mark and make a point there Now fasten both the ties at the middle pole and stretch the cord towards the south by the middle mark over this point and fix a pole at the place reached Fasten one tie at this pole, another tie at the easternmost

pole and stretch out the cord having taken it by the middle mark thus will be obtained the south eastern corner of the square (required) Then freeing the tie from the easternmost pole fasten it to the westernmost pole and again stretch the cord by the middle mark thus the south western corner will be determined Similarly can be determined the north eastern and north western corners of the square (Fig 23)

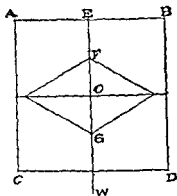


Fig 23

Method IV

Take a cord two times the measure of the given side of the square make a tie at both end and a mark at the middle With one half of this cord measure the east to west (breadth) of the square In the other half make a mark at a distance (from the western end) less by its one fourth Let this mark be called *nyañchana* Make another mark at the middle of that half for the purpose of (determining) the eastern corners Having fastened the two ties at the two extremities of the east to west breadth stretch the cord towards the south by the *nyañchana* mark Thus the two eastern and two

western corners of the square should be constructed by the middle mark of the other half of the cord "1 (Fig 24)

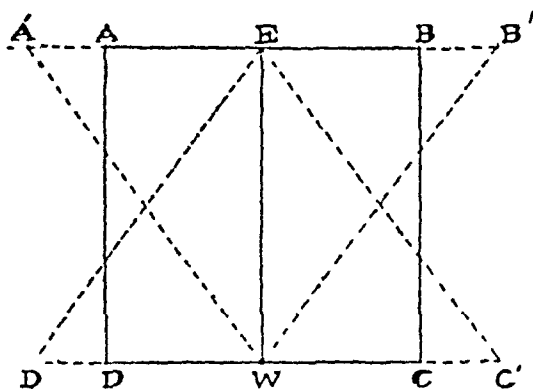


Fig 24

$EW = a$, the given side, $AE = EB = DW = WC = a/2$,
 $A'E = EB' = D'W = WC' = 3a/4$, $ED' = EC' = WA' = WB' = 5a/4$

Method V

"Add to a cord as long as the given side its half and make a mark at a distance (from the other end of the added portion) less by its sixth part. Fasten the ends of the (increased) cord at the extremities of the east-west line and stretch it towards the south having taken by the mark and put a sign at the point reached by it. Do similarly on the north and again on both sides after interchanging the ends of the cord. This is the construction "2 2 (Fig 25)

¹ BSl, 1 29 35

² $\bar{A}pSl$, 1 2

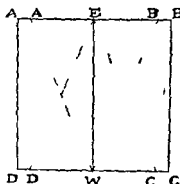


Fig 25

$EW = a$ the given side $AE = EB = DW = WC = a/2$
 $A'E = EB' = D'W = WC' = 5a/12$ $ED' = EC' = WA' = W\tilde{C} = 13a/12$

The Method I is described in full by Apastamba¹ It is noted and partly described by Baudhayana. This seems to be the oldest Hindu method for the construction of a square on a given straight line. For the practice of the measurement of the Fire altar with the bamboo rod is mentioned as early as the *Taittiriya Samhita* (c 3000 B C)³ and indeed reappears in almost all the early

¹ L. I.

² BSI, 13f

³ TS 5.1f

If the ly S i ta d B i n a i f u d myth lo c l
 l t betw n th Ag d the V (b m b o r o d) Th s
 T t y S m h t b e r v s H m t s w t h b m b o o t h b m b o o
 n e t e d t h A g n (d y i t e v) t o n t h m w t h h
 b r t h p l (5) Th c n e t n h b e n n r r t e d i n t h t w k
 t h u A g n w t a w y f m t h e g o d h n t e d t h r e e d h r e r t e d
 t o t h e h l e w h c h f m d b y t h p f r a t o n o f t h r e d Th
 m y t h l g y r p p e a r i n t h M t a y S i t a (2 4) d S t a
 p t a B h m a Th e l t t r d c b A g w t a w y f m t h e g o d e
 h n t d i t o s r e d w h n t i b l l o w s d w h n i n d e t s

Samhitās and *Bṛāhmanas* ¹ It is found to have been gradually replaced by the measurement with a cord which was introduced about the time of the *Satapatha Bṛāhmana* (c. 2000 B C) ²

The Method II occurs only in the *Baudhāyana Sulba* It is clearly based on the previous method and is indeed a combination of four operations by it ³

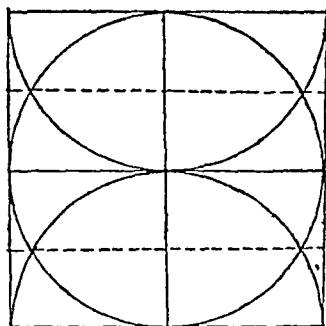


Fig 26

The Method III is taught by Āpastamba ⁴ and Manu ⁵ The latter emphasizes that it should be exclusively used in all cases of the construction of a square on a given

as it were, smoke tinged" (vi 3 1 26), again 'Agni went away from the gods He entered into a bamboo stem, whence that is hollow On both sides he made himself those fences, the knots, so as not to be found out, and wherever he burnt through, those spots came to be" (vi 3 1 31)

¹ *Maṇḍ.* iii 2 4, *Kṛṣ.* xx 3 4, *Kapṣ.* xxxii 5 6, *SBr*

² *SBr.* x 2 3 8 ff

³ Compare Bürk, *ZDMG*, lv, p 547

⁴ *Loc cit*

⁵ *Māṇḍ.* i 14-21, compare also vii 7 ff

straight line This method is also applied by Katya yana² It may be noted that the cord used in the course of the construction is called in the *Manava Sulba* by the technical name *pañcangī* (five jointed) because it has five (*panca*) joints (*anga*) i.e. two ties and three marks The rope has been sometimes called *patinī* (that which is laid out) because measurements are made by laying (*pata*) it out on the ground

The Method IV is given by Baudhayana³ Āpastamba⁴ Katya yana⁵ Manu⁶ and Maitrayana and the Method V by Āpastamba⁷ and Katya yana⁸ It is also taught by Baudhayana⁹ He would however restrict its application to the construction of a rectangle

To construct a rectangle of given sides

If you wish to construct a rectangle fix on the ground two poles as much apart as you wish (the length to be) On either sides (before and behind) of each of these poles fix two other poles at equal distances from it Take a cord as much as the breadth (of the rectangle) make a tie at both ends and a mark at the middle Having fastened the two ties at the two poles about the eastern pole stretch the cord towards the south by the mark and put a sign (where the mark touches the ground) Then fasten the two ties at the middle pole and again draw the

¹ *Ib d vii*

² *KS* 1 8 1 0

³ *L* t

⁴ *ApŚi* 3

⁵ *KSī* 12 3 c mp e also *ASIP* 16

⁶ *MāŚi* 5 11

⁷ *L* c t

⁸ *KSī* 1 14 5

⁹ *BŚī* 42 4

cord over the sign towards the south by the mark and fix a pole at the mark That is the south-east corner (of the rectangle) Thereby is explained (how to determine) the north-east corner and also the two western corners " 1

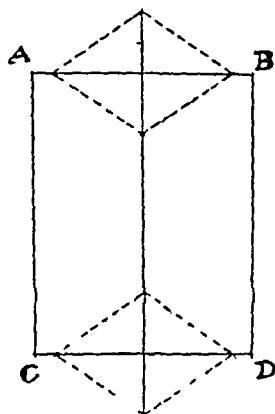


FIG 27

This method is alike in principle to that employed by Āpastamba and Manu for the construction of a square on a given straight line (*Method III*) Still Baudhāyana would restrict its application to the construction of a rectangle having given sides and of an isosceles trapezium having given face, base and altitude

To construct an isosceles trapezium of a given altitude, face, and base

To construct a trapezium whose altitude, face and base are given, Baudhāyana ² follows a method similar to the one adopted by him for the construction of a rectangle of given sides Only cords of given different measures are employed for fixing the extremities of the face and base

¹ BŚI, 1 36 40

² BŚI, 1 41.

The methods suggested by Āpastamba for the same purpose will be understood from those adopted by him for the construction of the *Mahavedi*. The shape of the *Mahavedi* is prescribed by tradition to be an isosceles trapezium whose altitude is 36 *pada* (or *prakrama*) face 94 (units) and base 30 (units). Āpastamba gives four methods for its construction. All of them are in principle the same. It is to draw a straight line through both the extremities of another straight line equal to the given altitude and at right angles to it. Along these straight lines and on other sides of the altitude are measured lengths equal to half the given lengths of the face and the base. And thus the isosceles trapezium is drawn. Āpastamba distinguishes between his different methods as *Ekaraṇṇaviharana* (The method of construction with one cord) and *Dvīraṇṇaviharana* (The method of construction with two cords)

Method I

Add to a cord of 36 (*pada* or *prakrama*) 18 and make a mark at 12 and a mark at 15 from its western end. Having fastened the ends of the cord to (the two poles at) the two extremities of the east west line (of 36 *pada*) stretch it towards the south by taking by the mark at 15

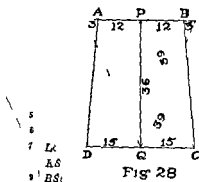


FIG 28

and fix a pole (at the point reached by the mark), (proceed) similarly towards the north. These poles are the two western corners of the *vedi*. For (determining) the two eastern corners, interchange (the ends of the cord) and then stretching it towards the south by the mark at 15, fix a pole at (the point reached by) the mark at 12, (proceed) similarly towards the north. These are the two eastern corners. This is the method of construction with one cord ''¹ (Fig 28)

Method II

" The diagonal of a rectangle whose sides are 3 and 4 (*pada* or *prākrama*) is 5. With these increased by three times themselves (are determined) the two eastern corners of the *vedi*. With them increased by four times themselves (are fixed) the two western corners ''² (Fig 29)

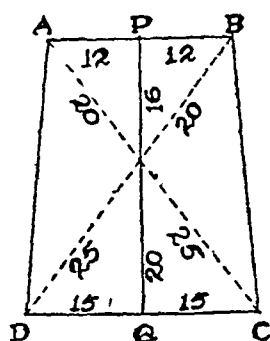


Fig. 29

$$3^2 + 4^2 = 5^2$$

$$3 + 3 \cdot 3 = 12$$

$$4 + 3 \cdot 4 = 16$$

$$5 + 3 \cdot 5 = 20$$

$$12^2 + 16^2 = 20^2$$

$$3 + 4 \cdot 3 = 15$$

$$4 + 4 \cdot 4 = 20$$

$$5 + 4 \cdot 5 = 25$$

$$15^2 + 20^2 = 25^2$$

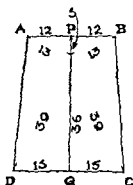
Method III

" The diagonal of a rectangle whose sides are 5 and 12, is 13. With them the eastern corners of the *vedi* (are

¹ *ĀpŚI*, v 2

² *ĀpŚI*, I v 3

determined) and with them increased by twice themselves the western corners (are fixed) ¹ (Fig 30)



$$5^2 + 12^2 = 13$$

$$5 + 2 \cdot 5 = 15$$

$$12 + 2 \cdot 12 = 36$$

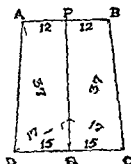
$$13 + 2 \cdot 13 = 39$$

$$15^2 + 36^2 = 39^2$$

Fig 30

Method IV

The diagonal of a rectangle whose sides are 8 and 15 is 17 with these cords the two western corners of the *vedi* (are measured) The diagonal of a rectangle of sides 12 and 35 is 37 with these cords (are measured) the east corners ² (Fig 31)



$$8^2 + 15^2 = 17$$

$$12 + 35^2 = 37^2$$

Fig 31

$$\begin{aligned} \Delta_{p81} &= 4 \\ \Delta_{p81} &= 5 \end{aligned}$$

Āpastamba observes " These are the known methods of construction of the (*Saumikī*) *vedi* " ¹

To construct a parallelogram having given sides at a given inclination

For the proper construction of an altar of prescribed size and shape, it was sometimes necessary to make bricks of the shape of a parallelogram having given sides at a given inclination. For instance, Āpastamba says

" Make a class of bricks, one-fifth of a *purusa* long and one-ninth of a *purusa* broad, (the two sides being) inclined (*nata*) suitably so as to fit (*yathā-yagamī*) " ²

The reference in the end of the rule is to the bent of the wing of the falcon-shaped altar where these bricks shall have to be used. Thibaut observes " By ' nata, bent' the *sūtrakāra* means to indicate the sides of the brick do not form rectangles. The shape of the brick is rhomboidical, the angles, which the sides form with each other are the same which the wings of the *śyena* form with the body " ³

Āpastamba does not expressly teach us how to construct a parallelogram of that shape. But it could be inferred from the method laid down for the construction of another parallelogram. He says,

" (Construct) bricks for the wing with four sides two sides one fourth *purusa* each and two sides of one-seventh *purusa* " ⁴

By the expression *pakṣastakā* (" brick for the wing ") is implied that the inclination between the two contiguous sides of these bricks must be the same as the bending of

¹ " Etāvanti jñeyāni *vedi-viharanāni bhavanti* "—*ĀpŚl* v 6,

² *ĀpŚl*, xvi 2

³ Thibaut, *Sulvasūtras*, p 31

⁴ *ĀpŚl*, xix 5

the wings where they are to be used. Now the bending of a wing has been defined thus ¹ Describe a rectangle $ABCD$ of breadth (AD) equal to 1 purusa and length (AB)

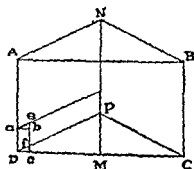


Fig 32

$2\frac{1}{4}$ purusa. Draw MN bisecting DC and at right angles to it. Draw DP one purusa long meeting MN at P . Cut off PN equal to DP . Draw AN , BN , PD , PC . This will give the bending of the wing.

Apa tamba teaches the following method for construction of the above *pakṣastala*.

Construct a rectangle ($abcd$) of length (ad) equal to one fourth of a purusa and breadth (dc) equal to one seventh of the side (DM) of (half) the wing. By the slanting side (DP) the mouth of this rectangle should be changed so that the sides (df and ce) might be bent to the one seventh of the slanting side of the wing (DP).

Thus we have the required parallelogram $acfd$ whose sides ad , f are equal to one fourth of a purusa each and sides fd , ac are each equal to one seventh of a purusa and they being inclined as specified.

¹ Cf. *śi* \times 68

² *ApŚi* \times 8

It should be particularly noticed that in the above the inclination between the two sides of the parallelogram to be constructed or between any two lines in general is not stated in terms of angular units (though the conception of such is not wanting in Hindu astronomy) but in terms of the relation between the sides and diagonals of a certain rectangle along which the two given lines would lie

Āpastamba gives also a slightly different method of constructing a parallelogram. He says

“ Draw a rectangle one-fifth of a purusa long from east to west, and one-tenth of a purusa broad, to the south as well as to the north of it draw another (rectangle of the same size). Draw the diagonals of them passing through their south-western corners ”¹

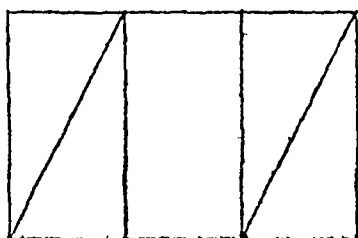


Fig 33

From this we can easily guess the method that was generally followed in the *Sulba* for the construction of a parallelogram having given sides at a given inclination. Let A , B represent the given sides and the inclination be the same as that between the diagonal PR and the side

¹ *Ibid*, xvi 8

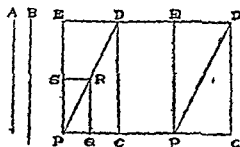


Fig 34

PQ of the rectangle $SRQP$. Now draw the rectangle $EDCP$ similar to the given rectangle such that its diagonal PD be equal to the given side B . Then draw the rectangle $DE'P'C$ so that its side CP' be equal to the difference between A and PC . Now draw the rectangle $E'D'C'P'$ equal to the rectangle $EDCP$. Join $D'P$. Then $DD'P'P$ is the required parallelogram. The Fig 34 answers to the case when $A > PC$. In case $A < PC$ the rectangle $DE'P'C$

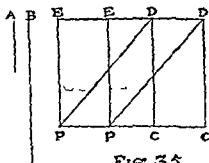


Fig 35

should be drawn so as to overlap the rectangle $EDCP$ (Fig 35)

CHAPTER VI

COMBINATION OF APFAS

To draw a square equivalent to n times a given square

The solution of this proposition practically depends upon the construction of squares and rectangles having given sides. By the so called Pythagorean Theorem, the square described on the diagonal of the given square will have an area twice as much. To draw a square thrice as much as the given square, the rule is:

“(Construct a rectangle whose) breadth will be the measure (of a side of the given square) and length its double-producer (i.e., diagonal). The diagonal of that rectangle is the treble-producer.”¹

By repeating the operation and constructing each time a rectangle whose one side will be equal to a side of the given square and another side equal to the diagonal of the rectangle constructed at the preceding stage, we shall finally arrive at one, the square on whose diagonal will be equivalent to n times the given square. This method is taught by almost all the writers.

Oftentimes the process can be much shortened by a skilful device. For instance, if n happen to be a square number, equal to p^2 , say, then the desired result will be obtained by drawing the square on a straight line p times a side of the given square. Thus Kātyāyana observes

“Twice the measure (of a side of a given square) is (its) fourfold-producer, thrice the measure is the ninefold-producer, four times the measure is the

¹ *BSI*, i 46, *ĀpSI*, ii 2, *KŚI*, ii 14

sixteenfold producer. As many units of a measure are in a cord so many row (or series) of squares (of that measure) there will be in a square on that cord as a side. Combine them.¹

If n is not a square number simplification can be made by expressing it when possible as the sum of two square numbers. Thus if

$$n = p^2 + q^2$$

where p, q are rational quantities then if x denote a side of the required square and c a side of the given square we shall have

$$x^2 = (pc)^2 + (qc)^2 = (p^2 + q^2)c^2 = nc^2$$

So that with one construction only we shall get a square n times the given square. Kity yana has given some instances of this kind. He says

(If a rectangle be drawn with) one pada (a unit of linear measure) as the breadth and three padas as the length its diagonal will be tenfold producer. (If a rectangle be drawn with) two padas as the breadth and six padas as the length its diagonal will be fortyfold producer.²

The first of these instances occurs also in the *Mānava Sulba*. Similar instances are also found in other works.

A simplification is also possible even if n is expressible as a multiple of a square number though not as the sum of two square numbers.

Kityayana gives another very elegant and simple method of finding a square equal to the sum of a number of other squares of the same size. He says

As many squares (of equal size) as you wish to combine into one the transverse line will be (equal to) one

¹ KSI 1 69 c mp 1 ApSI 1 67

² KSI 89

³ M SI 1 45

less than that, twice a side will be (equal to) one more than that, (thus) form a triangle. Its arrow (i.e., altitude) will do that"¹

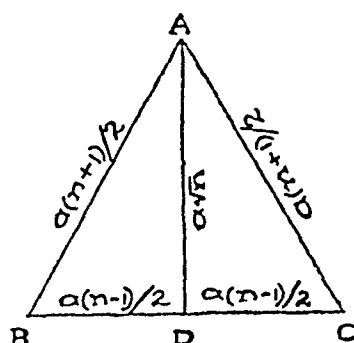


Fig 36

That is, if n be the number of equal squares to be combined together into one, form the triangle ABC whose base BC is of length $(n-1)$ times a side of a square and twice the sides AB and AC of which are severally equal to $(n+1)$ times a side of a square. The method of drawing the triangle, which will be consistent with the geometrical methods of the *Sulba* is this. Draw the line BC of length $(n-1)$ times a side of a square. Fix two poles at B and C . Take a cord of length $(n+1)$ times a side of a square. Fasten its two ends at the two poles and stretch the cord sidewise having taken it by the middle point. Let A be the point reached. Bisect BC at D and join AD . Then the square on AD will be equivalent to

¹ “यावत् प्रमाणानि समचतुरस्रख्येकौकर्तुं चिकीर्षेदेकोनानि तानि भवन्ति तिर्यक् दिगुखाख्येकत एकाधिकानि वस्त्रिर्भवति, तस्येषुस्तत्करोति।” —*KŚI*, vi 5

Compare also the *Parīśista*, verses 40 1

the sum of n given squares 1 or

$$\begin{aligned} AD^2 &= AC^2 - DC^2 \\ &= \left(\frac{n+1}{2}\right) a^2 - \left(\frac{n-1}{2}\right) a^2 \\ &= na^2 \end{aligned}$$

To draw a square equivalent to the n th part of a given square

After describing the method of drawing a square equivalent to 3 times a given square Baudhayana observes

Thereby is explained the generator of the third part (*tritiyāharaṇi* of the square) It is the ninth part of the area 1

Similar remarks occur also in the works of Āpastamba and Katyayana The former says

Thereby is explained the generator of the third part Division into nine (parts) 2 and the latter

Thereby is explained the generator of the third part Division of the given measure into nine parts 3

The commentators disagree about the method actually implied in the above rules According to some 4 it is this Find a square equivalent to three times the given square Then divide a side of this square into three equal parts A square drawn on any of these parts will be equivalent to one third of the given square For on drawing parallel lines through the points of division the second square will be divided into nine (square) parts Hence each part (square) is equal to one ninth of it and so

1 BŚI 47

2 ApŚI 3

3 KŚI 15 6

4 F 1. 1. 3 K p d m Su d ; a d Rām

to one-third of the given square According to others,¹ the method is this Divide the given square into nine equal squares Combine three of these squares into one And it will be equivalent to the third part of the given area Some² are of opinion that both the methods are implied by the text

Both the interpretations are valid inasmuch as they produce the correct result Thibaut prefers the first interpretation as it preserves in a better way the connexion of the above rule with those just preceding But the Sulbakāras appear to have implied both the methods Kātyāyana's rules following those noted above are

“ The third part of the side (of the given square) produces the ninth part of it Three of these ninth parts (on combination) will give the generator of the third part (of the given square) ”³

Again this is the method adopted by Baudhāyana in constructing the *Paṭrākī-vedi* which is square in shape and is equivalent to one-third the square on a side 18 padas long⁴ Further he has expressly adopted both the methods in measuring the *Sautrāmanikī-vedi*⁵

Proceeding in the same way we can find in general a square equivalent to the n th part of a given square Either First find a square equivalent to n times the given square. The square on the n th part of a side of this square will be equivalent to the n th part of the given square Or Divide a side of the given square into n equal parts On drawing parallel lines through the points of division, the given square will be divided into n^2 equal

¹ *Eg*, Dvārakānātha Yajvā

² Karavindasvāmī

³ *KŚI*, II 17 8

⁴ *Vide infra*, p 98f

⁵ *BŚr*, XIX 1

square parts. The square combining n of these elementary squares will be equivalent to the n th part of the given square.

The whole process will of course be much simplified if n be a square number equal to p^2 say. For in that case we shall have simply to divide a side of the given square into p equal parts. The square having one of these parts as a side will be equal to n th part of the given square. *Katy yana* furnishes us with some instances of this kind.

By means of half the measure (of the side of a given square) is obtained a square equivalent to the fourth part (of the given square) by one third the measure is obtained (a square equivalent to) the ninth part by one fourth the measure is obtained (a square equivalent to) the sixteenth part.¹

Similar instances are also given by *Apastamba*.²

To draw a square equivalent to the sum of two different squares

Baudhayana gives the following method of solution of this proposition

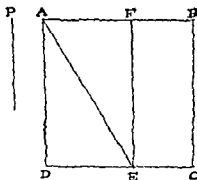


Fig 37

¹ *AS* 10 11

² *AS* 10

“ To combine two different squares, cut off from the larger a (rectangular) portion with a side of the smaller one. The diagonal of this segment will be a side of the sum ”¹

The same method is also taught by Āpastamba² and Kātyāyana³

Let $ABCD$ be the larger square and P a side of the smaller. Cut off BF and DE making each equal to P , and complete the rectangle $AFED$. Join AE . Then

$$AE^2 = AD^2 + DE^2 = AD^2 + P^2$$

The proof of this proposition will be evident from the Fig 38 which, in fact, simply represents the complete constructions taught in the *Sulba*

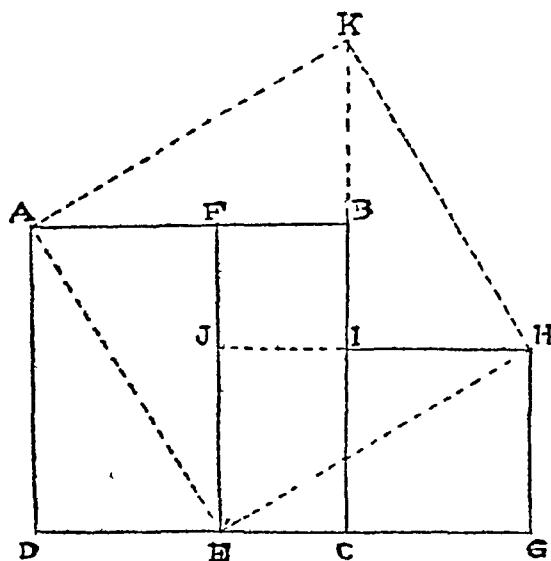


Fig 38

$$\begin{aligned} \square ABCD + \square BCFG &= \triangle ADE + \triangle AEF + \triangle EGH + \triangle EHJ \\ &\quad + \square BIJF, \\ &= \triangle ABK + \triangle AEF + \triangle HIK + \triangle EHJ \\ &\quad + \square BIJF, \\ &= \square AEHK \end{aligned}$$

Or $AD^2 + P^2 = AE^2$, since $CG = P$

¹ BŚI, 1. 22

ĀpŚI, 11. 1

³ KŚI, 11. 22

To draw a square equivalent to the difference of two different squares

For the solution of this proposition Baudhayana¹ and Apa tamba give the following rule

To deduct a square from a square cut off from the larger a (rectangular) segment with a side of the square which is to be deducted Then draw a longer side of this segment diagonally across to the other longer side and where it falls (on the other side) cut off that portion By this cut off portion the deduction is finished

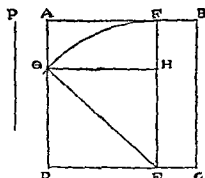


Fig 39

Let $ABCD$ be the larger square and P a side of the smaller square to be deducted from it Cut off AF and DE making each equal to P Join FE Draw FE by the extremity F so that it falls on AD at G Join GE Then

$$GD = GE - DE = AD^2 - P^2$$

This method is also taught by Katyayana²

¹ BSI 51

² ApSI
BSI 1

If the other side be one purusa the remainder will be three square purusas it has been stated (before) ¹

For the construction of a Fire altar of proper size and shape it is also necessary to know how to combine into a square figures of other kinds e.g. a square and a rectangle two rectangles ² No specific rules for this purpose are found in the *Sulba sūtra*. Hence it follows that such combinations shall have to be made with the help of the methods taught. Thus figures of every other kind are first transformed into squares and they are then combined into a square by the methods just described. This method has indeed been taught by Kātyāyana for the combination of triangles and pentagons.

To draw a square equivalent to two given triangles

After describing a method for the transformation of an isosceles triangle or a rhombus into a square Kātyāyana observes: By this is explained the combination of triangles. That is the triangles and rhombuses to be combined should first be transformed into squares severally and the sum or difference of these squares is then found by the methods already explained. The final result can of course be put in the shape of a square rectangle or triangle as required.

To draw a square equivalent to two given pentagons

Kātyāyana has also indicated a method for the combination of pentilaterals (*pañcalāṇi*)

By this is also explained a method for the combination of pentilaterals too. Break up a pentilateral of

¹ *Ap. 1* 6

² Cf. *Ap. 1* 8

equal angles into isosceles triangles, and break up a pentagonal of unequal angles into squares''¹

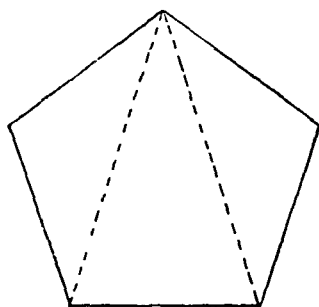


Fig 41

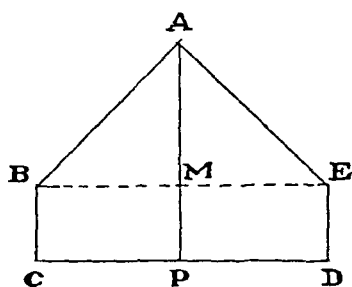


FIG. 42

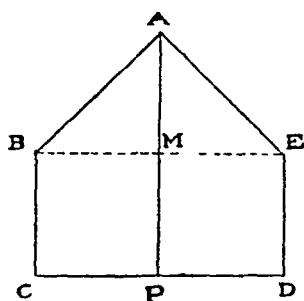


FIG 43

The latter part of this rule appears rather to be obscure. How to break up an irregular pentagon into squares? Mahīdhara has failed to grasp the matter accurately and hence made a worse confusion². I think

¹ KŚI, iv 8

² Mahīdhara has once explained *ekākarna* = "one triangle," *dvīkarna* = "two triangles," *trīkarna* = "three triangles" and *pañcakarna* = "five triangles." Later on he says *ekākarna* means "equal angles" and *dvīkarna* "unequal angles." His former interpretations are certainly wrong. If Kātyāyana had indeed meant "five triangles" by the term *pañcakarna*, what did he mean by the rule, "Pañcakarnānāṇi praṇṇīṇa apacchidyāṇīkaṇānāṇāṇi dvīkarnānāṇi samacaturasre apacchidyā" ["Break up *pañcakarnas* of *ekākarna* (variety) into isosceles triangles and break up *pañcakarnas* of *dvīkarna* (variety) into squares?"]

Katyayana has in view a pentagon of the shape $ABCDE$ in which $CP=PD=AM$ and $BC=MI=ED=CP/2$ (Fig 47) or in which CI PD AM BC MP ED are all equal (Fig 48). We find description of bricks of these shapes in the *Sulba* of Baudhayana¹ and they are ordinarily called *hamsamukhi* (of the shape of the mouth of a goose) Obviously a pentagon of that kind can be easily transformed into two or three squares of equal size. So that by combining the transformed squares we can find a square equal to the sum or difference of two or more pentagons.

CHAPTER VII

TRANSFORMATION OF AREAS

To transform a rectangle into a square

For this purpose Baudhāyana gives the following rule

“ If you wish to transform a rectangle into a square, make its breadth as the side of a square, divide the remainder into two parts and changing the place (of the farther one of them) and inverting, add it on the other side of the square. Then adding a (square) portion, fill up that (the empty space in the corner). It has been taught (before) how to deduct it (the added square from the full square thus formed) ”¹

Let it be required to change the rectangle $ABDC$ into a square

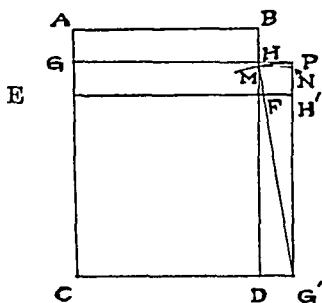


Fig 44

From the longer side AC cut off a portion CE equal to the breadth CD of the rectangle. Complete the square $CDFE$. Divide the remaining part $ABFE$ of the given rectangle into two halves by the line GH . Take the remoter half $ABHG$ and place it after inversion on the other side of the square $CDFE$ in the position $DG'H'F$. Complete

¹ *BSI*, 1 58

the square $CGPG$ by adding the portion $HPH'F$. The given rectangle is easily found to be equal to the difference of the two squares $GPG'C$ and $HPH'F$. This difference can be found by the method taught before. That is draw a circle with centre G' and radius $G'P$ cutting DH at M . Draw MN perpendicular to $G'P$. Then

$$G'N = GM^2 - MN^2 = GP^2 - HP^2$$

so that $G'N$ is the side of the square which is equivalent to the given rectangle $ABDC$.

The same method is taught also by Āpastamba¹ and Kātyāyana. The latter is a little more explicit than the other. He says

If you wish to transform a rectangle into a square cut off (from the rectangle a square portion) with its shorter side. Divide the other portion into two parts. Take the farther portion on the east and add it on the south (of the square portion). Complete the (square) figure by introducing a (small square) piece. The method for its deduction has been taught.

Kātyāyana suggests a different procedure for the transformation of a rectangle whose length much exceeds its breadth

If (the rectangle be) very long cut it again and again (into squares) by the breadth combine these squares into one square add to this the remaining portion (of the rectangle) after transforming it suitably.³

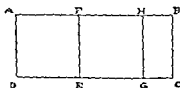


FIG. 45

¹ ApŚI ii 7

² KŚI 2

³ Ib d : 3

This is certainly no improvement on the other method. It will, in fact, require more operations to complete the desired transformation. The first method is very general and is equally available for all cases of transformation of a rectangle into a square.

To transform a square into a rectangle

Baudhāyana gives the following rule for transforming a square into a rectangle

“ If you wish to transform a square into a rectangle, divide it by the diagonal. Divide again one part into two, and add them suitably so as to fit the two sides (of the other half) ”¹

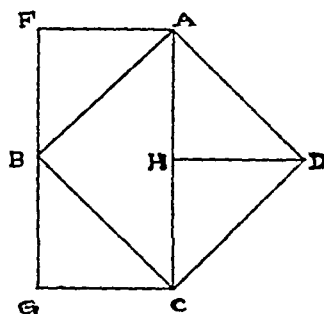


Fig 46

The same method is also taught by Kātyāyana.² This method is much circumscribed inasmuch as it transforms the given square into a rectangle in which the length is double the breadth and is itself equal to the diagonal of the given square.

To transform a square into a rectangle which shall have a given side

To transform a square into a rectangle which shall have a given side, Āpastamba gives the following rule

“ If you wish to transform a square into a rectangle,

¹ BŚI, I 52

² KŚI, III 4

(cut off from it a rectangular segment) by making a side as long as you wish (a side of the transformed rectangle to be) What remains in excess should be added (to the former) as suitably as to fit ¹

A similar rule is given also by Baudhayana

Or else if the square is to be transformed into (a rectangle) of this (i.e. one specified) side cut off (from the square) a segment by that side What remains in excess should be added along the other side

The latter portion of both the rules is obscure inasmuch as the operations to be employed have not been explained fully They were doubtless handed down by oral tradition

Thibaut ³ followed by Burk ⁴ thinks the method implied to be this Let the side of a given square be 7 units long It is to be transformed into a rectangle whose one side will be say 5 units long Cut off from the given square a rectangle of 5 by 7 units There will then remain in excess a rectangle of 7 by 2 units From this cut off a rectangle of 5 by 2 units and add it properly to the other portion Then remains a square of 2 by 2 units Change this into a rectangle of 5 by $\frac{4}{5}$ units and place it by the side of the previous rectangle so as to fit Thus we have finally a rectangle of 5 by $\frac{49}{5}$ ($=7+2+\frac{4}{5}$) units

This explanation is doubtless wrong For at the final stage it begs the original problem itself If the *Sulba* writers had really intended a simple arithmetical operation

¹ ApŚl 1.2

² BŚl 63 Thibaut's rendering of the beginning of this text is incorrect It should be अपि बसद्विचतुरस्रं अथ अपि चतद्विचतुरस्रं The form रर द न स ग by Uland's addition of the B dhāya Ś t Ś t and also appears my copy of the Baudhayana Ś lba

³ Ś lba Ś t 2 p 20

⁴ ZDMG LVI p 334

to be followed at the final stage of then method, as is supposed by Thibaut and Burk, they could have, and very likely would have, directed to adopt it at the preliminary stage, without taking recourse to any kind of geometrical operations at all. The method of Āpastamba and Baudhāyana was of course geometrical, not arithmetical.¹

According to the commentators Sundararāja and Dvārakanātha Yajvā, the method implied is similar to this:

“Produce the northern and southern sides towards the east as much as you wish (a side of the transformed rectangle to be Complete the rectangle and) draw the diagonal passing through its north-eastern corner (Find the point) where it cuts the transverse side of the (given) square lying inside that rectangle. Leave off the portion of that side lying to the north of that point and make its southern portion the breadth of a rectangle. That will be the rectangle (required).”²

¹ It may be noted that Thibaut has discarded on a different occasion certain arithmetical interpretation of a rule of Baudhāyana by Dvārakanātha Yajvā with the remark, “The commentary instead of showing how the desired end could be attained by making use of the geometrical constructions taught in the paribhāṣhā sūtras, employs arithmetical calculation, but this was of course not the method of the sūtrakara.” (*Pandit O S*, X, p 73)

Similarly Bürk remarks about certain explanation of the commentator Sundararāja “This explanation of *jñeyā* is incorrect because the Śulbasūtra deals with geometrical construction, and not with ‘numerical calculation’. In commenting *jñeyā* from the standpoint of arithmetic, the commentator falls into a similar error as disclosed by Thibaut in another case (*JASB*, XLIV, 272) (ZDMG, LVI, p 329)

² “यावदिच्छ पार्श्वमान्नी प्राची वडयित्वा उत्तरपूर्वा कर्णरज्जुनायच्छेत् । सा दीर्घ-चतुरस्रमध्यस्थाया समचतुरस्रतिथ्यङ्मान्या यत्र निपतति तत् उत्तर हिवा दक्षिणाश-तिथ्यङ्मानो कुर्व्यात् । तद्दीर्घचतुरस्रं भवति ।”

Let $ABCD$ be the given square and M the given length which is greater than a side of the square

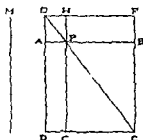


FIG 47

Produce DA and CB to E and F respectively so that $DE = CF = M$. Join EF and complete the rectangle $EFCD$. Draw the diagonal EC cutting AB at P . Then PB will be the breadth of the transformed rectangle. Through P draw the straight line HPG parallel to ED or FC . Then $HFCG$ is the rectangle which is equivalent to the square $ABCD$ and whose side CF is equal to the given length M . For

$$\triangle EFC = \triangle EDC$$

$$\triangle EHP = \triangle EAP$$

$$\triangle PBC = \triangle PGC$$

$$\text{parallelogram } HFBP = \text{parallelogram } AIGD$$

$$\text{Hence parallelogram } HFCG = \text{square } ABCD$$

Q. E. D.

Burk was led to suspect whether the method explained by the commentators was indeed in view of the *Sulbasaras* and to discard it ultimately for the simple reason that this method is so scientific. Thibaut has not directly assigned any reason for his rejection of the interpretation of the commentators. He seems however to have been led by an observation of Dvarakanatha Yajña anyacca prakārah (Also another method) which just precede his delivery of the method. But the preliminary

remark of Sundararāja is *ayamatīa piakārah* [“ This is the method (taught) here] ” The rule has been formulated by the two commentators in identical words So one has doubtless copied from the other Difference in the preliminary remark may be explained thus Sundararāja explains the method just after the above rule of Āpastamba which is its proper place But Dvārakanātha Yajvā gives it under the imperfect method of Baudhāyana for the transformation of a square into a rectangle which precedes his perfect rule stated above So it was very natural for him to remark that it is “ another method ”

Why Dvārakanātha Yajvā explains the method at a place other than what is proper for it seems very probably to be this The process as defined in the rules of Baudhāyana and Āpastamba does not begin, as has been already pointed out by Burk, with the construction of a greater rectangle (*EFCD* in Fig 47) as required in the above explanations of the commentators But it begins very clearly to cut off from the given square a smaller rectangle (*ABFE* in Fig 48). Or in other words the explanation of the commentators has in view the case in which the given length is greater than a side of the given square, whereas the rule of the Śulbakāras has in view the case in which the given length is smaller than a side of the given square So Dvārakanātha Yajvā was not wrong in calling the method described by him to be a different one This case was treated under the unsatisfactory rule of Baudhāyana undoubtedly as a sort of modification and improvement of it The case of the Śulbakāra has been explained by him in its proper place under the succeeding rule

The geometrical process in the case that was in view of the Śulbakāras is this From the sides *AD* and *BC* of

the given square $ABCD$ cut off AE and BF respectively ¹

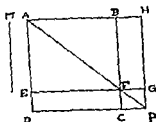


FIG 48

making each equal to the given length M which is smaller than a side of the given square. Join AF and produce it to meet DC produced at P . Complete the rectangle $ADPH$. Produce EF to meet HP at G . Then $AHGE$ is the rectangle which is equivalent to the square $ABCD$ and which has a side AE equal to the given length M . The proof is similar to that given before.

On one occasion Baudhayana makes a rectangle equivalent to three given squares one side of the rectangle being half of a side of a square ². This case is a very simple one indeed but it shows that he knew other methods of transforming a square into a rectangle than that indicated in his imperfect rule.

To transform a square or a rectangle into an isosceles trapezium which shall have a given face

Baudhayana gives the following rule for the transformation of a square or a rectangle into an isosceles trapezium or for what they call shortening of a square or a rectangle on one side.

¹ We take the length equal to M from the side AD and BC of the given square but in the side AB and CD we take the whole length directly. The length M should be made the perpendicular of the rectangle cut off.

“ If you wish to make a square or a rectangle shorter on one side (cut off a rectangular portion) by making the shorter length a side. Divide the remainder by the diagonal and place (the two portions) on either sides (of the portion cut off) after inverting.”¹

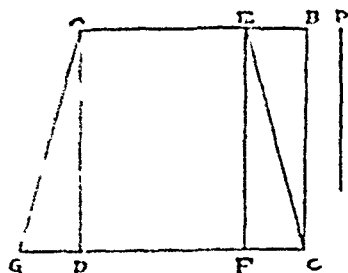


FIG 49

Let $ABCD$ be a given square and P a given line which is shorter than AB . From AB and DC cut off AE and DF respectively making each equal to P . Join EF and EC . Take the triangle CBE and place it after inverting in the position ADG . Then $AECG$ is the isosceles trapezium which is equal to the given square $ABCD$ and whose face AE is equal to the given length P .

We find a nearly similar rule in the *Satapatha Brāhmaṇa*². Let $ABCD$ be a rectangle. Take $AE = FB =$

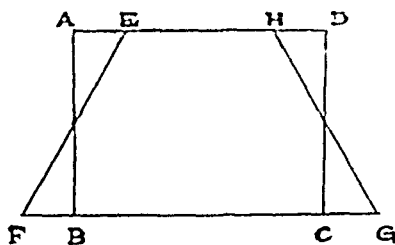


FIG 50

$DH = CG$. Then it is said that the trapezium $EFGH$ is

¹ *BSI*, 1 55

² *SBr*, 2 1 4.

exactly equal to the rectangle $ABCD$. This method reappears in the *Ipastamba Sulba*¹

To transform a square or a rectangle into a triangle

If you wish to transform a square or a rectangle into a triangle construct a square whose area will be twice as much as the area of the figure (to be transformed). Fix a pole at the middle of its eastern side. Having fastened at it two ties (of two cords) stretch the cords towards the two western corners. Cut off the portions lying beyond these cords.

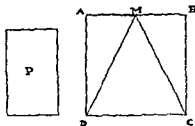


FIG 51

Let P be the given rectangular figure to be transformed. Draw the square $ABCD$ so that its area will be twice that of P . Let M be the middle point of AB . Join MD and MC . Then the triangle MCD is equal to the rectangular figure P . For each is equal to the half of the square $ABCD$.

To transform an isosceles triangle into a square

If you wish to transform an isosceles triangle into a square cut off its northern half by the middle line then place it on the opposite side after inverting. By the method of constructing a square equal to a rectangle

¹ *ApŚl* x 91

² *BŚl* i 56

construct the square This is the method of construction " 1

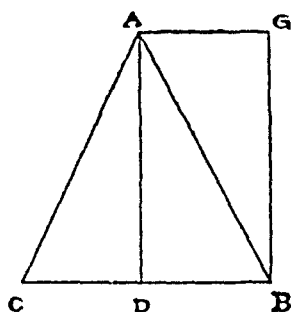


Fig 52

Let ABC be an isosceles triangle Draw the median AD Take the half ADC and place it after inversion in the position BGA Then the rectangle $AGBD$ is equal to the isosceles triangle ABC Now transform the rectangle $AGBD$ into a square by the method given before

To transform a square or a rectangle into a rhombus

" If you wish to transform a square or a rectangle into a rhombus, construct a rectangle which shall have an area twice as much as the area (of the figure to be transformed) Fix a pole at the middle of its eastern side Having fastened at it two ties (of two cords), stretch the cords towards middle (points) of the northern and southern sides (of the rectangle) Cut off the portions lying beyond (these cords) Thereby is also explained the construction of the other triangle " 2

Let P be a rectangular figure Draw the rectangle $ABCD$ so that its area will be double that of P Let G , H , E , F be the middle points of the sides AB , BC , CD ,

¹ *KSl*, IV 5

² *BSl*, I 57.

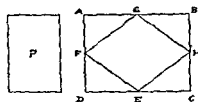


FIG 55

D4 respectively. Join GH HF EF FG . Then the rhombus $GHEF$ is equal to the rectangular figure P .

This method is taught by Baudhayana Āpastamba¹ and Katyavana².

To transform a rhombus into a square

Katyavana observes

If it be the case of (transformation into a square of) a rhombus bisect it by its transverse middle line. Then construct as before.

That is the rhombus is first divided into two isosceles triangles by drawing a diagonal. The triangles are then transformed into square by the method given before. Finally the two squares are combined into one square.

¹ *ApŚl* 111 9

² *KŚl* 4

³ *Id* 6

CHAPTER VIII

AREAS AND VOLUMES

The unit of area is defined by Āpastamba thus

“ By means of a measure is produced a measure ”¹

That is, the unit of surface measure or area is the area of a square on a side of unit length

In the *Sulba* we find express rules for the mensuration of square- and isosceles trapeziums only. It is certain that mensuration of certain other elementary figures, such as triangles and rectangles, was also known in that time. The area of the circle was only roughly approximate. Other kinds of rectilinear figures, particularly the Fire altars of various shapes enumerated before, were used to be mensurated by breaking them up into elementary triangles, squares and rectangles.

The number of square units in the area of a square is obtained by multiplying the number of linear units in a side by itself

Āpastamba and Kātyāyana state

“ As many units of a measure as are in a cord, so many rows (or series) of squares (of that measure) there will be in a square on that cord as a side ”²

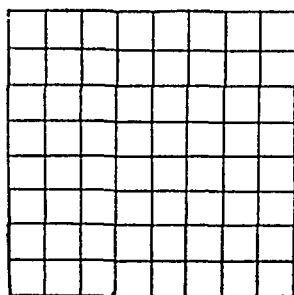


FIG 54

¹ *ĀpSl*, III, 4

² *ĀpSl*, III, 7, *KSl*, III, 9

This result was of course generalised so that the area of any square was used to be calculated by multiplying its side by itself

The number of square units in the area of a rectangle is obtained by multiplying together the numbers of linear units in the length and breadth of the rectangle

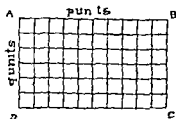


Fig 55

Let $ABCD$ be a rectangle whose length AB contains p units and whose breadth AD has q units. On dividing AB and AD and drawing parallel lines it is found that the rectangle $ABCD$ is divided into pq unit squares. Therefore its area is pq units of area.

It should be noted that we do not find in the *Sulba* any explicit rule for the mensuration of a rectangle. But there is no doubt that it was used to be done in the above way. Similarly from the method of constructing the *ubhay* bricks (Fig 7) which are of the shape of a scalene triangle and of the parallelograms (I₁, 325 cf also F o 14) it is clear that the following formulae also were known

Area of a triangle $\approx \frac{1}{2} (\text{base}) \times (\text{altitude})$

Area of a parallelogram $= (\text{base}) \times (\text{altitude})$

The area of a trapezium

How to find the area of a trapezium has been demonstrated by Apastamba in the course of determination of the area of the *Mahavedi* which is of the shape of an isosceles

trapezium whose altitude, face and base are respectively 36, 24 and 30 padas (or prakramas) He says

“ The *Mahāvedī* measures (in area) one-thousand less twenty-eight (square) padas Draw a straight line from the south-eastern corner (of the *vedī*) to a point 12 padas towards the south-western corner Place the portion thus cut off on the other (i.e., northern) side of the *vedī* after inverting it It (the *Mahāvedī*) will then become a rectangle After that construction the area will be apparent ” ¹

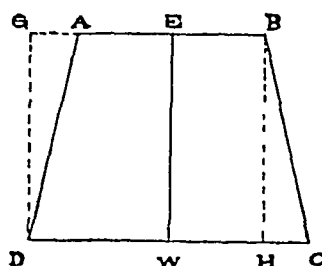


Fig 56

Let $ABCD$ be the isosceles trapezium Cut off $WH=EB$ Join BH Place the triangle BHC after inversion in the position DGA Then, the rule says, as is also obvious,

The area of the trapezium $ABCD$

$$\begin{aligned}
 &= \text{the area of the rectangle } GBHD, \\
 &= DH \times BH, \\
 &= \frac{1}{2} (AB + DC) \times BH, \\
 &= \frac{1}{2} (\text{face} + \text{base}) \times \text{altitude}
 \end{aligned}$$

This result also follows at once from the method indicated in the *Satapatha Brāhmaṇa* and by Baudhāyana for the transformation of a square or a rectangle into an isosceles trapezium ²

¹ *ĀpŚI*, v 7

² *Idē supra*, p 90f

Figures with a given area

For the construction of an altar of proper size and shape as prescribed by the Holy Scriptures it is sometimes necessary to describe a rectilinear figure having a given area. For instance it is prescribed that the *vedi* of the *Pitryajña* must be a square of an area equal to one ninth of that of the *Mahavedi*¹. Now the area of the *Mahavedi* is given to be 972 square padas. So the problem becomes to construct a square having an area of 108 square padas. Again it is said that the *Sautramaniki vedi* is of the form of an isosceles trapezium having an area equal to the third part of the *Mahavedi* that is to 324 square padas. According to Āpastamba and Ātīya-jana this isosceles trapezium must be similar to the shape of the *Mahavedi*. This case will be treated separately under Similar figures. But Baudhayana seems to have left the shape of the trapezium unrestricted. Hence there arises the problem to find an isosceles trapezium having an area of 324 square padas. According to the tradition of some schools it is necessary to construct square shaped altars of area varying from $1\frac{1}{4}$ to $6\frac{1}{4}$ square puruṣas.

To construct a square having an area of 108 square padas

Baudhayana gives the following method

One third producer (i.e. the side of a square whose area is one third the area) of the square made with the third part of the *Mahavedi* is that (the side of the *Paśtrivedi*). Its area is the ninth part of the area (of the *Mahavedi*)².

$108 = 324/3 = 18^2/3$. So the required square will be one third of a square on a side 18 padas long. The

¹ BSI, 81

² BSI, 14. ApSI, 1, 3

³ BSI, 8. Comp. R. P. d. 1. V (O. S.) p. 46f

method for this latter construction has been taught before. Let AB be a straight line 18 padas long. Divide it into three equal parts. Let AC be one such part. Describe the square $ACDE$. Join AD . Describe a circle with

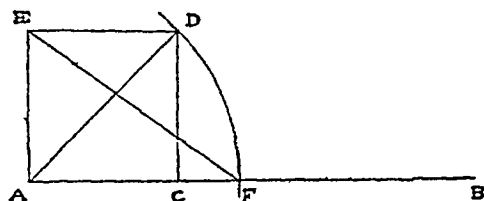


Fig 57

centre A and radius AD cutting AB at F . Join EF . Then EF is a side of the square having an area of 108 square padas. For

$$\begin{aligned} EF^2 &= EA^2 + AF^2, \\ &= EA^2 + AD^2, \\ &= 3AC^2, \\ &= \frac{1}{3}AB^2 \end{aligned}$$

$$EF^2 = 108 \text{ square padas}$$

This construction is the same as to find a square three times a square of 36 square padas. For $108 = 3 \times 36$. If 108 would have been a square number or expressible as the sum of the two square numbers, the solution would have of course been very easy.

To construct an isosceles trapezium having an area of 321 square padas

Baudhāyana says

“ If a square be formed with the third part of the *Mahāvēdi*, its sides will be each 18 padas long. Then by making it longer on one side and shorter on the other, the sides should be determined optionally as necessary ” ¹

The rule does not explain clearly how the sides of the square formed with the third part of the *Mahateti* are to be varied so that the modified figure may assume the shape of an isosceles trapezium but still retaining the same area. It seems however that the altitude is left unchanged only the face and base being varied

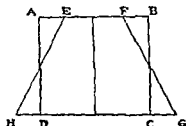


Fig 38

Let $ABCD$ be the square whose side AB is 18 padas long. Suppose $EFGH$ to be the modified form. Also suppose $EF = 18x$ and $HG = 18y$. Since the area must remain the same we must have

$$18 \left(\frac{18x + 18y}{2} \right) = 324$$

$$\text{or} \quad x + y = 2$$

Thus we can easily obtain any number of isosceles trapeziums having the same altitude and area.

We have explained before Baudhayan's method for the transformation of a square (or a rectangle) into an isosceles trapezium which shall have a given face. That is different from the one supposed here. But this method has one advantage over that it does not disturb the east-west line and so its adoption we think to have been more probable. If the altitude also vary we get an indeterminate equation of the form

$$x(x + y) = 2$$

where $18z$ is the altitude of the resulting isosceles trapezium

Volume of a Prism or Cylinder

We have so far treated of the shape and size of the base of the various kinds of Fire-altars and have observed that the size in all cases has been prescribed to be the same, namely, $7\frac{1}{2}$ square purusas. Every Fire-altar, save and except the one of the shape of the cemetery (*Smaśāna-cit*), has a perfectly horizontal surface whose height is prescribed to be one *jānu* ($=32$ angulis) for the first construction, two *jānus* for the second construction, and so on. Again the number of layers of bricks at successive constructions increases as multiples of five, and the shape and size of any layer of a particular Fire-altar at any construction is the same as those of its base. Hence all the Fire-altars are right prisms or circular cylinders. And the early Hindu geometers evidently knew the formula

$$\text{Volume of a prism or cylinder} = (\text{base}) \times (\text{height})$$

Approximate Volume of the Frustum of a Pyramid

The cemetery-shaped Fire-altar is in fact a frustum of a pyramid. Its base is an isosceles trapezium whose dimensions are stated by Baudhāyana to be as follows

“He should construct the *Smaśāna-cit* (‘the Fire-altar of the shape of the cemetery’) who desires ‘May I gain prosperity in the *Pitiloḥa* (the world of the fathers)’¹ it has been (taught). Six purusas are the length of the east-to-west line, three the length of the eastern side and two the length of the western side. This is the body (of that Fire-altar)”²

¹ The quotation is from *TS*, v 4 11 3

² *BŚr*, xvii 30

It should be remarked that the unit *purusa* in this passage is not the ordinary *purusa* of 120 angulis but a reduced unit whose length is equal to a side of a square equivalent to one half of the ordinary square *purusa* ¹ So the area of the trapezium is equal to 10 reduced square *purusa* or $7\frac{1}{2}$ ordinary square *purusa*s

The height of this Fire altar has been specified by Baudhayana thus

Its (*Smasana cit*) measure : when neck deep on the east navel deep on the west when navel deep on the east knee deep on the west when knee deep on the east ankle deep on the west and when ankle deep on the east it is on a level with the ground on the west ²

Notwithstanding this difference in height on the two sides of the Fire altar its cubic content has to be kept intact To effect that in practice the following device is generally adopted

Increase the (usual) vertical measure of the Fire altar by it one fifth Then divide the total height into three parts and make bricks with (the height equal to) the fourth ninth or fourteenth part of two of these part Construct four nine or fourteen layers with them Divide the remaining part (having constructed it with one layer of bricks of the height of one third the total height) by the diagonal (plane) inclined down toward the west and remove the half (i.e. the upper portion) ³

It has been prescribed that the *n*th construction of the Fire altar shall have a height of *n* *janus* and comprise of $5n$ layers of bricks Increasing the height by its one fifth we get $6n/5$ *janus* Two thirds of them gives $4n/5$ *janus* Up to this height the altar is constructed in $(5n-1)$

¹ B&I 534 *ṛpa* 1 *Th b t S h tr p* 40

² B&I vi 30

³ B&I i 668

layers, so that the height of each brick is equal to $(5n-1)$ th part of $4n/5$. One-third of the increased altitude is $2n/5$ jānus. Next layer of the Fire-altar is constructed with bricks of height $2n/5$ jānus. Then the upper portion of this layer is cut off by the diagonal plane as directed. Hence the altitude of the altar is now $6n/5$ jānus on the east, $4n/5$ jānus on the west, so that its average altitude is $(6n/5 + 4n/5)/2$ or n jānus. This device will be easily recognised to be based on the following approximate formula for calculating the volume of the frustum of a pyramid. If (a, b) be the length and breadth of the rectangular base of the solid, (a', b') the corresponding sides of the face parallel to it and h the height, then

$$\text{Volume of the frustum} = \left(\frac{a+a'}{2} \right) \left(\frac{b+b'}{2} \right) h$$

CHAPTER IX

THE THEOREM OF THE SQUARE OF THE DIAGONAL

There is one very important proposition which together with its converse looms much more considerably than anything else through the entire geometry of the *Sulba Brahmana* has enunciated it thus

The diagonal of a rectangle produces both (areas) which its length and breadth produce separately

That is the square described on the diagonal of a rectangle has an area equal to the sum of the areas of the squares described on its two sides. The proposition is defined in almost identical terms also by *Āpastamba* and *Katyayana* ³

This theorem is now universally associated with the name of the Greek *Pythagoras* (c. 540 B.C.) though no really trustworthy evidence exists that it was actually discovered by him ⁴ To denote it as shortly and clearly as possible *Hankel* suggested for it the name the Theorem of the Square of the Hypotenuse. It would be more in keeping with the form and spirit of the early Hindu geometrical terminology to alter this slightly to the Theorem

दीघचतुरश्रस्वाक्षरार्ज्जु पाञ्चमानी त्रिषड्मानी च यत्प्रयग्मूते
कुरुतस्तदुभय करोति । —BSI 48

Compare BSI x 19 1 for parallel with the theorem

दीघस्वाक्षरार्ज्जु पाञ्चमानी त्रिषड्मानी च यत् प्रयग्मूते कुरुतस्तदुभय
करोति । —ApSI 14

दीघचतुरश्रस्वाक्षरार्ज्जुत्रिषड्मानी पाञ्चमानी च यत् प्रयग्मूते कुरुतस्तदुभय
करोतीति चेद्विज्ञानम् । —KSI 11

of the Square of the Diagonal ” For the *Sulba* does not speak, as we do, of the right-angled triangle, but of the square and the rectangle Hence the altered title is adopted here

The employment of two different terms by compartment for what we denote by one, necessitated the ancient *Sulbakāras* to define the above proposition for the rectangle again with reference to the square

“ The diagonal of a square produces an area twice as much ” ¹

That is The area of the square described on the diagonal of a square is double the area of that square

The order in which these two and other closely related propositions is mentioned by different writers is noteworthy The oldest known *Sulbakāra*, *Baudhāyana*, states the second proposition before the first intervened by two other rules in the same connexion The posterior writers like *Āpastamba* and *Kātyāyana* place the second just after the first This change in the order in stating these propositions may not be entirely without any significance It shows that by the time of *Āpastamba* and *Kātyāyana* the importance and generality of the theorem of the square of the diagonal of a rectangle was recognised fully So they very naturally stated the corresponding theorem for the particular case of a square as a corollary to it But from the point of view of the origin and growth of the theorem, *Baudhāyana*’s arrangement is more natural

Another proposition which has been most freely used in the *Sulba* for the construction of a right angle is this

“If a triangle is such that the square on one side of it is equal to the sum of the squares on the two other sides, then the angle contained by these two sides is a right angle ”

¹ *BŚI*, 1 45, *ĀpŚI*, 1 5, *KŚI*, 11 12 For applications of the theorem compare *BŚr*, x 19, *xix* 1, *xxvi* 10

This converse proposition is not found explicitly defined by any Sulbakara but its truth is tacitly assumed by all of them

Did the ancient Hindus discover a proof of the theorem of the square of the diagonal? No conclusively satisfactory answer which will be beyond a shadow of doubt can be given to this question. For there is not found any mention direct or indirect of such a proof even if it had existed anywhere in the early literature of the Hindus. So what we shall say on this point will be more or less conjectural based of course on other matters having positive bearing on the point in question. It may be pointed out that the state of affairs is not much better elsewhere. It has been already stated that though the proposition is now universally associated with the name of the Greek Pythagoras no really trustworthy evidence exists that it was actually discovered by him. The tradition which attributes the theorem to him began five centuries after Pythagoras and was based upon a vague statement which did not specify this or any other great geometrical discovery as due to him. This led some eminent scholars like Hankel¹ and Jung² even to deny to Pythagoras the discovery of the proposition of the theorem of the square of the diagonal. Again the method which is supposed by the modern believers of the Pythagoras hypothesis to have been presumably followed by him to prove the theorem is purely conjectural³. So in the same way we proceed to discuss how the theorem was proved by the ancient Hindus. It may be noted

H Hankel *Z. Ges. h. ch. t. d. M. th. Alte t. l. um. d. Mitt.*
lt. Leipzig 1874 p. 97

G. Jung *Was h. b. d. a. Gri. schen. da. Ir. t. ion. l. ntdeckt.*
N. a. Symb. l. J. a. h. m. Hall 1907 pp. 1264 q. t. d. by
Heib. (E. l. d. I. p. 351)

H. ib. *E. l. d. I. pp. 35 ff.*

that Bürk and Hankel are definitely of opinion that the Hindus had a general geometrical proof. So also was, and more pronouncedly, the eminent German philosopher Schopenhauer.

The rule of Bṛudhāyana immediately following that containing the enunciation of the general theorem of the square of the diagonal runs thus

“ This (i.e., the truth of the theorem) is perceived in the rectangles with sides of three and four (units), twelve and five, fifteen and eight, seven and twenty-four, twelve and thirty-five, fifteen and thirty-six (units) ”¹

The Sanskrit terms are *trilacatuskayoh*, etc. They literally mean, “ the rectangle whose sides have three (units) and four (units), ” etc.

From this one might surmise that the ancient Hindus were aware only of the arithmetical character of the theorem and then by an imperfect generalisation applied it to rational rectangles. But such a surmise will be too hasty. For there cannot be absolutely any doubt about the fact that the Hindus fully recognised the most general geometrical character of the theorem and employed its truth universally. Indeed, we find instances of its application to cases of rectangles whose sides cannot be represented by rational quantities. For instance, for the construction of the *Sautrāmanīhī-vedi*, application is made of the right-angled triangle ($15/\sqrt{3}$, $36/\sqrt{3}$, $39/\sqrt{3}$) or ($5\sqrt{3}$, $12\sqrt{3}$, $13\sqrt{3}$) and for the *Aśvamedhukī-vedi* of the right-angled triangle ($15\sqrt{2}$, $36\sqrt{2}$, $39\sqrt{2}$).

The propositions about the combination and transformation of areas which we have noticed before may also be cited in this connexion. Perfectly geometrical character of them cannot be questioned.

Above all there is the remark of Katyayana at the end of his enunciation of the general theorem of the square of the diagonal of a rectangle *iti ksetrajñanam* or this is the knowledge of (plane) figures. Thibaut renders it as

this is the knowledge (requisite) for (the measurement of) areas. This is evidently inaccurate. For in the *Sulbasutra* the area is technically called *bhumi*; not *ksetra* which denotes figures. These prove conclusively that the universal geometrical character of the theorem was fully recognised.

On the other hand the above rule of Baudhayana suggests that the truth of the theorem of the square of the diagonal was perceived and proved in the case of rational rectangles first and it was then generalised and found to be true universally. This is perfectly natural. In support of this hypothesis may be cited the rule of Āpastamba and Katyayana for the calculation of the area of a square

As many units of a measure as are in a cord so many rows (or series) of squares (of that measure) there will be in a square on that cord as a side.¹

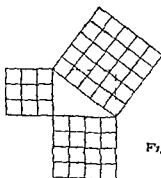


FIG. 59

So that by drawing the squares on the sides and diagonal of a rational rectangle and dividing them into

¹ *ĀpŚ!* 7 *KŚ!* 1 9 *V d s p* p 95

elementary squares it will be easily found by calculation that the square on the diagonal is equal to the sum of the squares on the sides

This hypothesis as regards the proof of the theorem presupposes a knowledge of the rational rectangles. How the ancient Hindus discovered such rectangles we shall discuss in the next chapter

The rules of Baudhāyana just preceding the one containing the proposition of the theorem of the square of the diagonal of a rectangle are these

“ The diagonal of a square produces an area twice as much

“ (Take a rectangle whose breadth is (equal to) the measure (of the side of a square) and length (equal to) its *dvikaranī*, its diagonal will be *trikaranī* (‘ three-fold-producer’ of the square)

“ Thereby is explained the *trītiya-karanī* (‘ the generator of the third part ’ of the square), it is the ninth part of the area ”¹

If this arrangement of the propositions can be supposed to give any clue as to the discovery of the theorem of the square of the diagonal, then it will have to be said that the theorem for a square was discovered first. In that case the hypothesis about the discovery of a proof of the theorem must be a little different from the one suggested above

Now one of the oldest Hindu Fire-altars is the *Caturaśra-śyenacit*. The oldest method for its construction does not presuppose a knowledge of the theorem in question. This method had been expressly taught by Āpastamba. It was undoubtedly known to Baudhāyana who hints it very briefly and gives in fact what is rather an improved form of it. Burk² surmises that the proof of the theorem was

¹ BSl, I 45 7, see also BŚr, xix 1

² Burk, ZDMG, LV, pp 556 f

discovered just in the figure of the *Caturasra syenacit*. The square $ACFE$ on the diagonal AC of the square $ABCD$ of the four squares forming the *atman* (or body)

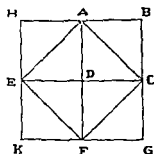


Fig 60

of this altar is obviously equal to the square $ADEH$ on the side AD and the square $DCGF$ on the side DC . Burk has further confirmed his hypothesis by a reference to Baudhayana's imperfect rule (taught also by Katyayana) for the transformation of a square into a rectangle.

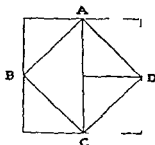


Fig 61

This hypothesis about the discovery of the proof of the theorem of the square of the diagonal of a square is

endorsed also by Heath ¹ It is certainly more likely than the one suggested by Cantor ² and Allman ³ about Pythagoras' proof of the theorem (Fig 62)

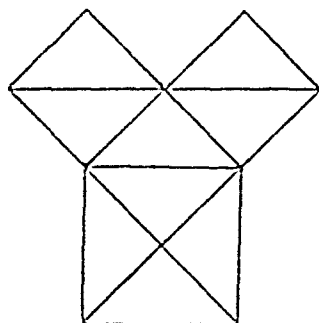


Fig 62

Thibaut says " The authors of the sūtras do not give us any hint as to the way in which they found their proposition regarding the diagonal of a square, but we suppose that they, too, were observant of the fact that the square of the diagonal is divided by its own diagonals into four triangles, one of which is equal to half the first square [Fig 63] This is at the same time an immediately convincing proof of the Pythagorean proposition as far as squares or equilateral rectangular triangles are concerned " ⁴

¹ T L Heath, *The Thirteen Books of Euclid's Elements*, in 3 volumes, Cambridge, 1903, Vol I, p 352

It may be noted that this proof of the particular case of the theorem of the square of the diagonal was adduced with the figure, as that of its general case, by Al khowārizmī (c 825) (F Rosen, *The Algebra of Mohammed Ben Musa*, London, 1831, pp 74f)

² M Cantor, *Vorlesungen über Geschichte der Mathematik*, 3rd ed, Bd I, p 185

³ J C Allman, *Greek Geometry from Thales to Euclid*, Dublin, 1889, p 29

⁴ Thibaut, *Sulbasūtras*, p 8

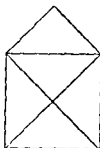


Fig 63

Burk thinks that this supposition is less probable because it has no connecting link with the constructions ordinarily met with in the *Sulba* also because it does not explain what might have induced the *Sulbakaras* after they had drawn one square to construct a new square on the diagonal of the same

Such construction is not really as unnatural for the *Sulbakaras* as is supposed by Burk. It is indeed clearly in evidence in the pattern of the first layer of bricks in the first kind of construction of the *Lakṣapākṣa śyenacit* as described by Baudhayana. To draw the attention directly the relevant portions of it are here marked with bold lines ² (Fig 64). Further Baudhayana teaches us to construct a square (brick) with half the diagonal of another square. This leads to a construction of the kind supposed by Thibaut.

However similar objections may also be raised partly at least against the supposition of Burk. What might have led to the drawing of the diagonals of the four squares forming the body of the *Caturasra śyenacit*? They are not required as a matter of course

BSI II 6 104

BSI 87 104 Comp. e P. 4 t V I X (O S) p 11

² *BSI* II 39

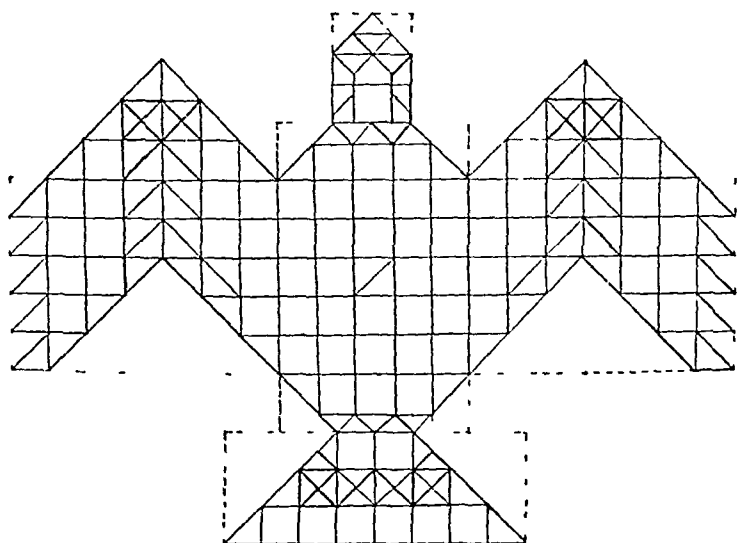


Fig 64

Vakṣapakṣa-syenacit

First layer of construction (after *Baudhāyana*)

An equally convincing hypothesis, which is very nearly alike to that of Burk but free from all those defects, is suggested by the method of construction of the *Paṭrkī-vedi*. According to one tradition about that *vedi*, it is a square of one square *purusa* in area whose corners are turned towards the cardinal directions ¹ For its construction *Kātyāyana* indicates the following method

“ For the *Paṭrkī(-vedi)*, construct a square whose area is two square *purusas*, fix poles at the middle of its sides (The figure formed by lines joining these poles will be the *vedi* required) This is the method of construction ” ²

Mention of that tradition about the *Paṭrkī-vedi* is made also by *Baudhāyana* ³ In fact, the construction of

¹ *KŚr*, ८.१. 3 28.

² *ASl*, 11 6

³ *BŚl*, 1 83 4

a square with its corners pointed towards the cardinal directions is mentioned as early as the *Satapatha Brahmana*¹ But how to do it has not been indicated there This is to be accounted by the fact that the method which is undoubtedly the same as that described by Katyayana was too well known In fact it seems to have been the usual practice in all such cases Compare Baudhayana's imperfect method for the transformation of a square into a rectangle where also it is necessary in the beginning to construct a square whose corners are turned towards the cardinal directions The common method for the transformation of a square into a triangle and a double triangle or rhombus may also be referred to

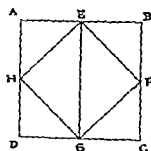


Fig 65

It is thus learnt that the figure *EFGH* obtained by joining the middle points of the sides of a square *ABCD* was known to be square in shape and half the original square in area Now the original square *ABCD* was naturally recognised as equivalent to the square on *EG* which is the east west line For as has been described

¹ ŚB xii 8 1 5

² The figure was happily used by Harkliff to show the possibility of the discovery of the theorem. Both were first to be expected that the geometry of the ŚB

before the usual practice of the Hindus for the construction of a square (or indeed any other regular figure) of given sides was to construct it in such a way as to make it lie symmetrically on the east-west line. This EG is again the diagonal of the newly formed square $EFGH$. So this figure leads in a very simple and vivid way to the discovery and proof of the theorem of the square of the diagonal of a square. If we join HF , we at once obtain the construction forming the basis of Burk's hypothesis.

How the ancient Hindus proceeded next to find a general proof is well hinted by the following two propositions of Kātyāyana preceding that of the general theorem of the square of the diagonal of a rectangle

“(Take a rectangle whose) breadth is one pada and length three padas, its diagonal is the ‘ten-fold-generator’ (i.e., it generates a square ten times as large as a square of one pada)

“(Take a rectangle whose) breadth is two padas and length six padas, its diagonal is the ‘forty fold-generator’ (i.e., it produces a square forty times as large as a square of one pada)”¹

It is evident from Fig. 66 that the square $ABCD$ is equal to ten elementary squares, four forming the inner square $OPQR$ and the remaining six from the halves of

¹ *KŚI*, II 89. Compare *KŚr*, V 3 33, for an application of the first rule and XVII 3 14 of the second.

In the manuscripts of the *Kātyāyana Śulba* known to me, there occurs a rule intervening between these two propositions and the proposition of the general theorem of the square of the diagonal

“The measure of the *yuga* and the *samyā* has been taught (before as it is found (in the holy scriptures))”—*KŚI*, II 10

I think this rule has been placed here erroneously by a copyist. So there is a gradual development of the proposition of the theorem of the square of the diagonal from the particular cases to the most general one.

According to this supposition we are to draw four rectangles equal to the given one each having as its diagonal a side of the square on the diagonal of the given rectangle. Then it follows obviously,

$$c^2 = 4(\frac{1}{2}ab) + (a-b)^2,$$

$$\text{or } c^2 = a^2 + b^2$$

We thus find from the *Sulba* how by successive stages the ancient Hindus developed, as is highly probable, a general proof of the theorem of the square of the diagonal. As confirmatory to this hypothesis, we may refer to the method of Āpastamba for the enlargement of a square. If it be required to construct a square whose side will exceed a side b of a given square by a , add, says Āpastamba,¹ on the two sides of the given square two rectangles whose lengths are equal to b and breadths to a , then add on the corner a square whose sides are equal to the increment a . Thus will be obtained a square with a side equal to $a+b$ (Fig 68). A similar method is taught by Baudhāyana.² Now we can divide the added rectangles by their diagonals and place the four resulting triangles of sides a, b, c around another square of the same size as the enlarged square, in the manner shown in Fig 67.

Nearly the same figure as Fig 67 is formed by the constructions described in the *Sulba*, for the combination of two different squares (Fig 38). The general truth of the theorem was very likely perceived from that figure.³

¹ *ĀpŚl*, III 9. See also p 176 *infra*.

² *BŚl*, III 192.4

³ Compare C. Müller, "Die mathematik der *Sulvasūtra*," *Abhandl. d. math. seminer d. Hamburgischen Univ.*, Bd VII, 1929, pp 175-205, more particularly pp 191 ff.

The above proof of the theorem of the square of the diagonal is given in later times in India by Bha kara II (1150) ¹ Bretschneider conjectures that Pythagoras proof of the theorem was substantially the same In approving of this hypothesis of Bretschneider Hankel remarks that it has no specific Greek colouring but rather reminds of the Indian style ³ This remark has been accepted by Allman ⁴ Gow and Heath ⁵ Heath has pointed out another objection against accepting that as Pythagoras proof though he admits it to be the best ⁷ This interesting proof was given also by Chang Chun Ching (c 200 A D) in his commentary of the ancient treatise *Chiu per* (c 1100 B C) ⁸

Another plausible hypothesis will be that the ancient Hindus were led to the discovery of the general proof of the theorem of the square of the diagonal in the following way Let $ABCD$ be a given square Draw the diagonal AC and cut off AE equal to AC Construct the square $AEFG$ on AE Join DE and on it construct the square $DHME$ Complete the construction as indicated in Fig 60 Now the square $DHME$ is seen to be comprised

¹ Bha kara II (c 1150) *Bha kara II* d E dh ka D ved nd Mur I
dh Jha B 197 p 0

² C A B t b d D G ometr e d d e G e met o
E M d L e p g 180 p 8

³ H H kel Z G k hte d r M th mat k s R t m d
n H elalt L p z g 1874 p 98

⁴ G J Allman G k G omet y f m T l l t E l d D bl
1883 p 37

⁵ J G w A Sho t H sto y f G k Mathem tic C mb d
1884 p 15 f

⁶ H th E l d I p 355

⁷ Heath E l d I p 335 Gr k M th I p 149

⁸ Y Mik m Th Pyth g a Th o em A ch M tl P ly
XXII (3) 191 pp 14 Th D lopme t f Mat lam t n Ch d
J p L e p 1913 p 5

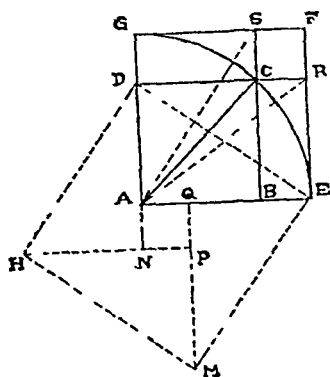


FIG. 69

of four right-angled triangles each equal to DAE and the small square $ANPQ$. This square will be easily recognised to be equal to the square $CRFS$ and triangles equal to the rectangles $AERD$ and $ABSG$. Therefore the square $DHME$ is equal to the sum of the squares $ABCD$ and $AEFG$. Hence the theorem. Constructions like this are necessary in the usual course in the *Sulba*.¹

Early History

The early history of the theorem of the square of the diagonal, in India, has been very ably treated by Burk.² We have now discovered a few more corroborative evidence of unquestionable value as regards its ancient character. In the *Sulba*, the theorem is found to have been applied very extensively. Even in the construction of a square, a rectangle or a trapezium, is ordinarily presupposed a knowledge of its converse. We may, however, presume for the sake of the best argument on the adverse that in the anterior times, those simple geometrical figures were used to be constructed by methods which would not

¹ For instance see Fig. 57, see also *Pandit*, O S, X, pp. 46 f.

² Burk, *ZDMG*, LV, pp. 546 ff.

form ¹ For the *Prauga-citi*, one has again to double that square Hence the theorem must be as old as the *Taittirīya* and other *Saṃhitā* (c 3000 B C) where, it has been pointed out before, occurs the express mention of the construction of the *kāmya Agni* In the *Satapatha Brāhmana*, we are asked to construct a square fourteen times as great as another square of one purusa. Again it is required to divide the small square into seven parts and three of the parts will have then to be combined with the larger square to form a new square ² From that *Brāhmana*, we come to know of some ancient authorities who used to approve of the construction of a series of *Agni* of the square shape, with areas $1\frac{1}{2}$, $2\frac{1}{2}$, $6\frac{1}{2}$ square purusas ³ These have been incidentally mentioned by Baudhāyana ⁴ and Āpastamba ⁵ But the *Satapatha Brāhmana* particularly forbids the construction of such altars That is, however, quite immaterial for the object we have now in view It is sufficient and important for us to know that such constructions which clearly depend upon the addition of squares were once in vogue, at any rate in some particular schools, before the time of the *Satapatha Brāhmana* (c 2000 B C) In one of the cases noted above it is necessary to transform a rectangle into a square before it can be added to another In the *Śrauta-sūtra*, we find copious instances of the geometrical construction of $\sqrt{2}$, $\sqrt{3}$, etc Some of those instances can be clearly distinguished from all the previous ones

¹ Cf Burk ZDMG, LV, pp 549, 553

² SBr, x 2 3 7-14 For further particulars in this connexion see Chap XII

³ Ibid, x. 2 3 17

⁴ BŚI, iii 318 9

⁵ ĀpŚI, viii 3, 5, xii 1-2, ĀpŚr, xvi 17 15 In this work, the tradition is expressly attributed to the *Satapatha Brāhmana*

inasmuch as in them the application of the theorem of the square of the diagonal has been very clearly mentioned ¹ In the *Baudhayana Śrauta* the converse theorem is used for the construction of the *Mahavedi* ² Thus we learn that the theorem of the square of the diagonal really plays a very important part in the science of altar construction from very early times and in some cases it is in fact indispensable

¹ For example we take the following from the earliest *Śrauta* namely the *Baudhayana Śrauta*

अथ महावदि विमिमीत एतानेव व्यायस प्रक्रमप्रक्रम्याणां व्यायसनेन प्रमाय समन्तं व्यायसा परितनोति । पृष्टा मातनीत्यद्यतर्माद्य प्रत्यक्ष यूपावटीयाश्च ङी विमिमीते पुरुषमावण वीणना समपक्षपुच्छमरविना पक्षा द्वाघोयोसौ भवत । षड्विध वा समविध वा द्वादशविध वा यावद्विधं वा क्षेत्रमासी भवत्यद्यनमस्यायामानेन प्रमाय समन्तं व्यायसा परितनोति । —BS x 19

वदिद्वितीय यजतति विद्यायते । तस्या सोमिक मानमेतावन्व नाना । सोमिकात् प्रक्रमानृतीयोऽथ प्रक्रम स्वात्तेन वति विमिमीते । अपि वा यदाच्या पात्रमानी पत्र तिर पशुमानेन तयाय कणसमित प्रक्रम स इत्यने । पत्राहा नवमस्तन्त्याया तयोस्तु य कणसमित स प्रक्रमार्थेन मीया सामिकौ वदि ।

—BS i 1

C mp i BS xxv 10

BSr v

CHAPTER X

RATIONAL RECTANGLES

In the *Sulba-sūtra* we meet with the following rational rectangles

$$(a)^1 \quad 3^2 + 4^2 = 5^2,$$

$$(i)^2 \quad 9^2 + 12^2 = 15^2,$$

$$(ii)^3 \quad 12^2 + 16^2 = 20^2,$$

$$(iii)^4 \quad 15^2 + 20^2 = 25^2,$$

$$(iv)^5 \quad 72^2 + 96^2 = 120^2.$$

$$(b)^6 \quad 5^2 + 12^2 = 13^2,$$

$$(i)^7 \quad 15^2 + 36^2 = 39^2,$$

$$(ii)^8 \quad 40^2 + 96^2 = 104^2$$

$$(c)^9 \quad 7^2 + 24^2 = 25^2$$

$$(d)^{10} \quad 8^2 + 15^2 = 17^2.$$

$$(e)^{11} \quad 12^2 + 35^2 = 37^2$$

¹ *BŚl*, i 49, *ĀpŚl*, v 3

² *KŚl P*, verse 31

³ *ĀpŚl*, v 3

⁴ *ĀpŚl*, v 3

⁵ *MāŚl* iii 4 6

⁶ *BŚl*, i 49, *ĀpŚl*, v 4

⁷ *BŚl*, i 49, *ĀpŚl*, v 2, 4, *MāŚl*, v 2 3

⁸ *MāŚl*, iii 3, *MaŚl*

⁹ *BŚl*, i 49

¹⁰ *BŚl*, i 49, *ĀpŚl*, v 5

¹¹ *BŚl*, i 49, *ĀpŚl*, v 5

Besides these of which the sides and the diagonal are rational integers we find also a few other rectangles whose sides and diagonal are expressible in rational fractions

$$(a\ v)^1 \quad (2\frac{1}{4})^2 + 3^2 = (3\frac{1}{4})^2$$

$$(a\ vi)^2 \quad (7\frac{1}{2})^2 + 10^2 = (12\frac{1}{2})^2$$

$$(b\ iii)^3 \quad (1\frac{1}{2})^2 + 4^2 = (4\frac{1}{2})^2$$

$$(b\ ii)^4 \quad (2\frac{1}{2})^2 + 6^2 = (6\frac{1}{2})^2$$

$$(b\ v)^5 \quad (2\frac{1}{2})^2 + 5^2 = (5\frac{1}{2})^2$$

$$(b\ vi)^6 \quad (4\frac{1}{2})^2 + 10^2 = (10\frac{1}{2})^2$$

$$(b\ vii)^7 \quad (11)^2 + 27^2 = (29)^2$$

$$(b\ viii)^8 \quad (18\frac{1}{2})^2 + (188)^2 = (203\frac{1}{2})^2$$

It will be very interesting to know how the early Hindus discovered their rational rectangles. Thibaut observes. Most likely they discovered that the square on the diagonal of an oblong the sides of which were equal to three and four could be divided into twenty five small squares sixteen of which composed the square on the longer side of the oblong and nine of which formed the area of the square on the shorter side. Or if we suppose a more convenient mode of trying they might have found that twenty five pebbles or seeds which could be arranged

¹ KSl P r e 5f

² M Sl

³ M Sl

⁴ ApSl 6 M&Sl M Sl

⁵ ApSl 7

⁶ ApSl 8

ApSl 3

⁸ ApSl 5

in one square, could likewise be arranged in two squares of sixteen and of nine. Going on in that way they would form larger squares, always trying if the pebbles forming one of these squares could not as well be arranged in two smaller squares. So they would form a square of 36, of 49, of 64, etc. Arriving at the square formed by $13 \times 13 = 169$ pebbles, they would find that 169 pebbles could be formed in two squares, one of 144, the other of 25. Further on 625 pebbles could again be arranged in two squares of 576 and 49, and so on " 1

Thus Thibaut supposes that the Hindus had, starting from a greater square, obtained two smaller ones by division. Burk on the other hand supposes that they started more likely from a smaller square and found that the new square formed by increasing it was the sum of two smaller ones,—the original square and the square formed by the added portion. This supposition, indeed, tallies more with the procedures found in the *Sulba*. For instance, take the method of construction of the *Sarathacakra cit* described by Baudhāyana. There one has to make, as an auxiliary construction, a square with 225 plus 64 altogether 289 square bricks. Baudhāyana says

" With these bricks a square is to be formed. The side of a square (first formed) comprises sixteen bricks. Thirty-three bricks will still remain in excess. With them construct the borders (on two sides) completely round " 2

It will seem strange that instead of being directed to construct the whole square at once, we are told to make at first a square with 256 bricks and then to place the remaining 33 bricks around its two sides. As has been rightly pointed out by the commentator, this rule must be

¹ Thibaut, *Sulvasūtras*, p. 12

² *BŚ*, in 191 4

explained by the fact that the process of construction really began with a square consisting of 4 bricks. Next square was constructed by placing 5 squares along its two sides so that it contained 9 bricks. Proceeding thus and placing the additional bricks alternately on the north and east sides and on the south and west sides a square of 256 bricks was constructed without disturbing the position of symmetry of the altar about the east west line. But the addition of the remaining 33 bricks displaced this symmetry and for this reason perhaps Baudhayana gave that unusual direction¹.

This explanation is however immaterial for the purpose of our immediate object. It is quite sufficient that we have found that a new and larger square was used to be formed from another of smaller size by adding to it a portion in the form of a gnomon. More particularly it is found that a square comprising of 289 square bricks 17 on each side was formed from another of 225 bricks 15 on each side by the addition of a gnomon consisting of 64 square bricks. Thus is obtained the rational rectangle $15^2 + 8 = 17$

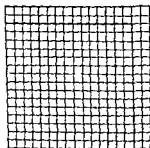


Fig 70

The whole process appears in a nutshell in the general

rule for the enlargement of a square which has been explained before. It is then simply by noting when the square bricks comprising the gnomon can also be placed

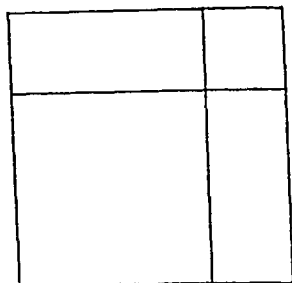


Fig 71

in the form of a square that the Hindus very likely discovered the rational rectangles. As has been suggested by Treutlein,¹ and followed by Allman² and Heath,³ it was substantially in the same way that Pythagoras discovered the rational right-angled triangles which are now generally associated with his name.

The number of rational rectangles employed in the *Sulba* for the purpose of the construction of altars is found to be few. It will be fewer still—five only—if we consider the independent ones, leaving out the multiples or sub multiples of them. So it will be naturally asked were the early Hindus aware of other rational rectangles? Had they any general rule for finding any number of rational rectangles?

In dealing with these questions, we shall first refer to two observations of Āpastamba which appear to imply an answer in the negative. After describing four methods

¹ P. Treutlein, *Zeits f Math u Phys*, xxviii, 1883, Hist.-litt. Abtheilung, pp. 209 ff.

² Allman, *Greek Geometry*, pp. 30 ff.

³ Heath, *Euclid*, I, p. 358.

of construction, the *Mahavedi* in which use has been made of altogether eight rectangles of which the sides and the diagonal are expressible in rational integers. Āpastamba observes ¹

Etavanti jñeyani vedi uharanani bhavanti

Thibaut has the reading *vijñeyani* in the place of *jñeyani* given by Burk and also found in my manuscripts. The difference is however immaterial. Thibaut translates the passage thus: So many cognizable measurements of the *vedi* exist. Burk renders it as: There are so many recognizable (*erkennbare*) constructions of the *vedi*.² and has thus closely followed Thibaut. The latter further observes: That means these are the measurements of the *vedi* effected by oblongs of which the sides and the diagonal can be known: *i.e.* can be expressed in integral numbers. Burk is of the same opinion.

The other observation of Āpastamba which we shall refer to is

tabhirjñeyabhīruktam uharanam

and it occurs at the end of his enunciation of the theorem of the square of the diagonal of a rectangle.³ Burk renders it thus: The construction (in 1, 2 and 3) has been taught by means of (the application of) these (the *akṣanayarajju parśvamani* and *tiryakmani* of a rectangle) — of course by means of such as are recognizable (*i.e.* which can be expressed in integral numbers).

Thus according to the supposition of Thibaut which is accepted also by Burk the qualifying words *jñeyani* and *jñeyabhīruktam* imply only those rectangles of which the sides and the diagonal can be expressed in rational integers.

ApŚi 6

² Thibaut *Śi* 1. 1 a p. 1

³ ZDMG LVI p. 341 comp. 1 p. 323 LV p. 60 f. 3

⁴ *ApŚi* 4

This supposition is doubtless wrong. For in the first expression the word *jñeyāni* very clearly qualifies *vedī-viharanāni* or "the methods of construction of the *vedī*," the word *vedī* undoubtedly referring to the *Mahāvedī* mentioned in the foregoing rules. This is further confirmed by the word *etāvani* meaning "these," "so many," the reference being to the four methods of constructing the *Mahāvedī* described by Āpastamba. Where is then the ground to suppose, as has been done by Thibaut and Burk, that *jñeyāni* implies the rectangles employed for the purpose of those methods? In the second passage the word *viharanam* ("construction" or "the method of constructions") clearly ¹ refers to the methods of construction described in the two foregoing rules, viz, *ĀpŚl*, 1 2 and 3, and the word *jñeyābhūh* to the rational rectangles used therein. This has been admitted by Burk also. Now the methods referred to are those for the construction of squares and rectangles of given sides, and they primarily depend upon drawing right-angled triangles (or rectangles) having a given side, or more particularly, having a side equal to a side of the required figure. The sides and the diagonal of the rectangles are stated to be $(a, 5a/12, 13a/12)$ and $(a, 3a/4, 5a/4)$. It is only when a is a multiple of 12 (in the first case) or a multiple of 4 (in the second case) that the sides and the diagonal of the rectangles employed for the purpose of the construction of altars, will be expressible in rational integers, other-

¹ Compare what Āpastamba says *uktam* "said," "stated" or "described," meaning that the method of construction has been described before. This can be further confirmed by referring to what Āpastamba has written in the rule just preceding the one under discussion (1 3). After stating the dimensions of the sides and the diagonal of the rectangle to be used, viz, $(a, 3a/4, 5a/4)$, Āpastamba observes *vyākhyātam viharanam*, "the method of construction has been (already) described (in the preceding rule)"

wise not. Indeed in actual practice Āpastamba has employed four particular cases of the first viz $(2\frac{1}{2} \ 6 \ 6\frac{1}{2})$ $(2\frac{1}{4} \ 5 \ 5\frac{3}{4})$ $(4 \ 10 \ 10')$ and $(11\frac{1}{2} \ 27 \ 29\frac{1}{2})$ which have fractional sides and diagonals ¹

Again for the purpose of the construction of altars Āpastamba has used even such rectangles in which the sides and the diagonal cannot be expressed in terms of rational numbers ² So the interpretation of the words *jñeyani* and *jñeyabhih* as supposed by Thibaut and Burk is absolutely untenable

Having detected that this interpretation is open to such a serious objection Heath modifies it and says

But the words (*etdiantī jñeyani* etc) also imply that the theorem of the square of the diagonal is also true of other rectangles not of the recognisable kind that is rectangles in which the sides and the diagonal are not in the ratio of integers this is indeed implied by the constructions for $\sqrt{2}$ $\sqrt{3}$ etc up to $\sqrt{6}$ (cf II 2 viii 5) ³ But he would still presume that the remark implies that Āpastamba knew of no other rational rectangles that could be employed

Let us next turn to find how the passages in question have been explained by the orthodox commentators. Amongst them the most elaborate explanation of the expression *tabhirjñejabhir* etc is found to be that of Karavindasvami. According to him the word *jñeya* implies that variety of quadrilaterals in which of the sides and the diagonal any two being given the third can be known with the help of the theorem of the square of

¹ ApSt v 68 1.3

² $\frac{1}{2} d$ p p 11. Further it is to be noted that in Āp t mb h d th l ht gl d t og l q a) a $\sqrt{2}$ (I 3)

³ Heath's *Elements* p 363

the diagonal, or it denotes the rectangles which "can be conceived in mind," the sides and the diagonal of them being expressible in terms of commensurable quantities¹ The first explanation is given also by Sundararāja and the alternative one by Kapardisvāmī Sundararāja is silent about the true import of the word *jñeyāni* in *etāvantī jñeyāni*, etc In the opinion of Karavindasvāmī and Kapardisvāmī, it implies those rectangles in which the sides and the diagonal "can be known in terms of numbers which are rational (*śuddhamūla*, lit 'which are perfect roots')"²

These interpretations appear to me to be as unnatural and forced as those of Thibaut and Burk Every one of

¹ Karavindasvāmī writes

“प्रमाणकारपार्श्वमानीतिर्यङ्मान्यक्षारज्जुनामन्यतरयोः परिमाणज्ञाने अन्यतरा ज्ञातुं शक्यते ता ज्ञेयाः । तत् कथं अक्षारज्जुफलभूतत्वेनात् पार्श्वमानी-फलभूतत्वे च शोधिते शिष्टत्वेन करणो तिर्यङ्मानोति ज्ञातुं शक्यते । एवमेता-ज्ञेयाः । या एवं ज्ञेयाः ताभिरेताभिरुक्त विहरणमित्यर्थः । एवमुत्तरस्य विहरणस्य समाधिहेतुत्वमवगन्तव्यमित्यर्थः । अथवा ज्ञेयाभिः परिकल्पयितुमुचिताभिः पूर्वोक्त-विहरणं कर्तव्यमित्यमर्थः ।”

Sundararāja says

“आसा द्वयोर्ज्ञातयोस्तृतीया ज्ञातुं शक्यते । यथा, पार्श्वमानीतिर्यङ्मान्यो-र्ज्ञातयोस्ते पृथग् वर्गयित्वा सयोज्य तद्वर्गमूलमक्षारज्जुस्तथा पार्श्वमान्यक्षारज्ज्वोर्ज्ञातयो-रक्षारज्जुवर्गात् पार्श्वमानीवर्गं विशोध्य शिष्टस्य मूलं तिर्यङ्मान्येव तिर्यङ्मानोवर्गं विशोध्य पार्श्वमानीः । एव ताभिर्ज्ञेयाभिः पूर्वोक्तं विहरणं ।”

Kapardisvāmī has

“ज्ञेयाभिर्ज्ञातुं शक्याभिर्मेतसा परिकल्पिताभिः ।”

² Karavindasvāmī says

“ज्ञेयानि शुद्धमूलतया ज्ञातुं शक्यानि ।”

Kapardisvāmī says

“एतावन्येव शुद्धमूलानि ज्ञातुं शक्यानि वेदिविहरणानि भवन्ति । अन्ये तु अशुद्धमूलाः कल्पयितुमशक्याः । तस्मादेतावनन्तीत्येवावधार्यन्ते ।”

these interpretations is putting a construction on the text which it does not seem to bear. At any rate those interpretations have been made irrespective of the sense in which the words very closely related to *jñeya* have been used in the *Sulba* and of the nature and spirit of these works.

The question of the rationality or irrationality of the sides and the diagonal of the rectangles used in the construction of altars can arise only when we begin to think of them in terms of numerical quantities. But the *Sulba* deals truly with geometrical construction and not with numerical calculation. In commenting upon *jñeya* from the standpoint of numerical representation the commentators ancient as well as modern have fallen into an error.¹

I think that the word *jñeya* should be explained quite differently. Its literal significance is as has been explicitly stated by the commentators can be known (*jñatum śakyate*). It comes from the same root *jñā* as the word *viññajate* meaning is known. Hence both the words should be explained so as to exhibit the same relation. Now on many occasions in the *Sulba* in connexion with the statements of the measurements of altars the description of the methods of construction them etc. we find the remark *iti viññajate*.² It implies that such and such thing is known from the ancient holy scriptures. Indeed those things can be actually traced therein. I think the word *jñeya* also should be explained as implying a reference to the same ancient scriptures. Thus the expression *tabhirjeyabhir*

It is noted that the use of the present applied by
B. K. G. Nath, P. P. T. f. S. d. 1
Fr. inc. BSI 65 71 76 79 t. ApSt 1 1 3 5
v 1 8 10 1 4 7 to

etc , means “ the method of construction (of the altars) has been described by means of those rectangles that can be known (from the ancient scriptures) ” The other expression *etāvantī jñeyāni*, etc , will then mean “ these only are the methods of construction of the (*Mahā*)-*vedī* which can be known (from the ancient scriptures) ”

We shall now take up the question whether the ancient Hindus had any general method of finding rational triangles Of course there is not found in the *Sulba* any rule devoted particularly to the definition of such a method So whatever we shall say on the point will consequently be by way of inference, more or less conjectural However there are good reasons to believe that the Hindus knew of general formulas for finding rational rectangles

We have already pointed out how the ancient Hindus presumably discovered the rational rectangles which are found in the *Sulba* by noting when the square bricks comprising the gnomon added to a square might themselves be arranged again in the form of a square Observing that the gnomon of one square brick depth put round a square formed with n^2 such bricks, consists of $2n+1$ bricks, they would have only to make a square with $2n+1$ bricks ¹

If we suppose that $2n+1 = m^2$,
we obtain $n = \frac{1}{2}(m^2-1)$,
and therefore $n+1 = \frac{1}{2}(m^2+1)$

It follows that

$$m^2 + \left(\frac{m^2-1}{2}\right)^2 = \left(\frac{m^2+1}{2}\right)^2. \quad (A)$$

This formula follows, indeed, more directly from a special rule of Kātyāyana for finding the sum of a number of equal squares If n be the number of equal squares of

¹ Compare Müller, *loc cit*, pp 202 f

sides equal to a each to be combined into one then the rule says

$$na^2 = \left(\frac{n+1}{2}\right)^2 a^2 - \left(\frac{n-1}{2}\right)^2 a^2$$

Putting m for n we get

$$m^2 a^2 + \left(\frac{m^2-1}{2}\right) a = \left(\frac{m+1}{2}\right)^2 a \quad (A)$$

In particular taking $a=1$ we get at once the formula (1) If the sides and the diagonal of the rectangles are to be integral as well as rational m must be odd

With the help of this formula would be obtained the following rational rectangles mentioned in the *Sulba* (3 4 5) (5, 12 13) and (7 24 25) Indeed it will give all those rational rectangles in which the difference between the greater side and the diagonal is 1

There are also found other rational rectangles viz (8 15 17) and (12 35 37) which could not be obtained from the formula (A) The characteristic of them is that the difference between the greater side and the diagonal is 2 They could be obtained from the formula

$$(2m)^2 + (m-1) = (m^2+1)^2 \quad (B)$$

which is derivable from (A) by doubling the side of each square or from (A) by putting $a=2$ But they were more likely obtained first by observing when the gnomon of two square bricks of breadth put round a square could be rearranged in the form of a square If the original square contain n bricks the gnomon will consist of $4n+4$ bricks

If we suppose that $4n+4 = m$

we obtain $n = \frac{1}{4}(m^2-4)$

and therefore $n+2 = \frac{1}{4}(m^2+4)$

It follows that

$$m^2 + \left(\frac{m^2-4}{4}\right)^2 = \left(\frac{m^2+4}{4}\right)^2$$

Substituting $2m$ for m in this, we easily obtain the formula (B)

Proceeding in the same way they could deduce from the general rule for the enlargement of a square, a still general formula for finding rational rectangles. It has been stated in that rule that the gnomon of n bricks depth put round a square of p^2 bricks will contain $2pn + p^2$ bricks. Supposing

$$2pn + n^2 = m^2,$$

we obtain
$$p = \frac{1}{2n} (m^2 - n^2),$$

$$p + n = \frac{1}{2n} (m^2 + n^2)$$

It follows that

$$m^2 + \left(\frac{m^2 - n^2}{2n}\right)^2 = \left(\frac{m^2 + n^2}{2n}\right)^2,$$

or
$$(2mn)^2 + (m^2 - n^2)^2 = (m^2 + n^2)^2 \quad (C)$$

where m, n are any two rational integers

This formula follows also from the method of the transformation of a rectangle into a square, which is commonly found in all the works on the *Sulba*. If p, q be the length and breadth of the rectangle to be transformed, it has been stated that the equivalent square will be given by the difference of the two squares

$$\left(\frac{p+q}{2}\right)^2 \text{ and } \left(\frac{p-q}{2}\right)^2 \text{ Thus}$$

$$pq + \left(\frac{p-q}{2}\right)^2 = \left(\frac{p+q}{2}\right)^2$$

Substituting $m^2 - n^2$ for $p - q$ respectively we get

$$m \cdot n + \left(\frac{m - n^2}{2} \right)^2 = \left(\frac{m + n^2}{2} \right)^2 \quad (C)$$

Proclus (450 A D) has attributed the formula (A) to Pythagoras (c 540 B C) and the formula (B) to Plato (c 375 B C). The formula (C) or (C') follows from Euclid's *Elements* II 6.

The early Hindus recognised that fresh rational rectangles can be derived from a known one by multiplying or dividing its sides and diagonal by any rational quantity. In other words they found that if (p, q, r) be a rectangle so that

$$p^2 + q^2 = r^2$$

then another will be (lp, lq, lr) where l is any rational number integral or fractional. Āpastamba has indeed derived certain new rational rectangles in the same way. He has however put the result thus:

$$\text{If } \alpha^2 + \beta^2 = \gamma^2$$

$$\text{then } (\alpha + n)^2 + (\beta + n\beta)^2 = (\gamma + n\gamma)^2$$

where n is an arbitrary rational number.

The rational rectangle (15, 36, 39) perhaps deserves more than a passing notice. It could of course be derived from the rational rectangle (5, 12, 13) by multiplying its sides and diagonal by 3. This relation has indeed been expressly admitted by Āpastamba. But it was probably obtained first independently, thinks Burk³ as an instance of a rational rectangle in which the difference between the greater side and the diagonal would be 3. This will probably account for Baudhāyana's enumerating it separately along with (1, 13). The early Hindus

particularly those belonging to the Āpastamba school; appear, however, to have special regard for the rational rectangle (15, 36, 39). So the method of constructing several *vedis* has been described in the *Sulba* of this school with particular reference to this rectangle. For instance, take the case of the *Nirūdhapaśubandha-vedi*. It is of the shape of an isosceles trapezium whose measurements are known from the ancient scriptures to be face=the yoke of a cart (=86 angulis), altitude=the pole (=188 angulis) and base=the axle of the cart (=104 angulis)¹. As regards the process of its construction, Āpastamba says

“ This has been described (in connexion with the construction of the *Saumikī-vedi*) by means of one cord. Having taken it by the mark at 15, fix the two western corners by means of half the axle and the eastern corners by means of half the yoke ”²

Here it is clear that the altitude (=188 angulis) of the *vedi* is supposed to be divided into 36 parts, so that one part will be equal to $5\frac{2}{3}$ angulis. On taking this for a new unit of pada or prakrama, in terms of it the altitude of the *Nirūdhapaśubandha-vedi* will contain 36 padas or prakramas. So the rational rectangle (15, 36, 39) can be applied to construct it, as in the Method I, page 64 (Fig 28). The spatial magnitudes of the rational rectangle employed will truly be $(78\frac{1}{3}, 188, 203\frac{2}{3})$ in terms of the usual unit anguli. But by supposing the unit to be one of $5\frac{2}{3}$ angulis, Āpastamba represents it as (15, 36, 39). Similarly in constructing several other altars, by a suitable change of the length of the unit of linear measure, Āpastamba always represents the sides and the diagonal of the rational rectangle employed by (15, 36,

¹ *ĀpŚI*, vi 3, 5, *ĀpŚr*, vii 3 7 f

² *ĀpŚI*, vi 4, compare Bürk's notes on it

39) ¹ Actually they are particular cases of the rectangle (a 5a/12 13a/12) a being the length of the altitude of the *vedi* under construction

Now it will be very naturally asked why this preferential liking for the particular rational rectangle (15-36-39) on the part of Āpastamba? The true answer will be not simply because as Burk seems to think that the construction of the most important *vedi* namely the *Mahavedi* or the *Saumikī vedi* depended on it. For Āpastamba has described as many as four methods for the construction of the same *vedi*. But also because it was employed in the most ancient method of constructing the *Mahavedi* and so had acquired a special sanctity by a long scriptural tradition. We have also seen the similar orthodox predilection of Āpastamba for the primitive methods of high scriptural antiquity in the matter of the construction of the *Caturasra śyenacit* by means of the bamboo rod.

Now tracing the early history of the rational rectangle (15-36-39) we find it first in the *Taittiriya Samhita* (c 8000 B C) ² in connexion with the *Mahavedi*. It has then reappeared in the *Kaṭhaka Samhita* ³ *Maṭrayani Samhita* ⁴ *Kaṣīṭhala Samhita* ⁵ and *Satapatha Brahmana* ⁶. It should perhaps be noted that in these works only the sides (15-36) have been expressly mentioned but not the diagonal 39. This non mention of the diagonal has led some modern writers to suspect if the property $15^2 + 36^2 = 39^2$ was at all known in the time

¹ ApŚl 68

² TS vi 2 4 5

³ KṛS x 4

⁴ M S ii 8 4

⁵ K pS xxiv 6

⁶ SB i 5 1 1ff x 3 4

of the *Samhitā* and *Brāhmaṇa* ¹ But such a suspicion seems to be quite unwarranted. For even in later times Baudhāyana has not mentioned the diagonal of the rational rectangles enumerated by him. From a thorough discussion of the point, Burk concludes "After all these no doubt can exist regarding the fact that the rational right-angled triangle with perpendicular sides 15 and 36 was really known in the time of the *Taittiriya Samhitā* and the *Satapatha Brāhmaṇa* and was employed in the construction of the *Saumikī-vedi* as in the *Āpastamba Sulba Sūtra* v. 1 and 2" ² Such was also the opinion of Cantor ³ Their conclusion will be further corroborated by what has been shown just above about the special sanctity acquired by this rational rectangle amongst the followers of the *Āpastamba* school. Our interpretation of the word *jñeyābhik* occurring at the end of *Āpastamba*'s enunciation of the theorem of the square of the diagonal of a rectangle (pp 132 f) also will lead one strongly to the same conclusion

¹ For instance, see Keith, *Journ. Roy. Asiat. Soc.*, 1909, pp 590 f., 1910, pp 519 f

² *ZDMG*, LV, pp 555 f.

³ Cantor, *Geschichte*, I, pp 598 ff

CHAPTER VI

SQUARING THE CIRCLE

To transform a square into a circle

Baudhayana says

If you wish to circle a square draw half its diagonal about the centre towards the east west line then describe a circle together with the one third of that which lies outside (the square) ¹

The same method has been taught also by Āpastamba ² and Katyayana ³

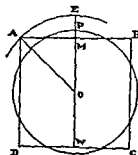


Fig 72

Let $ABCD$ be a square and O its central point Join OA With centre O and radius OA describe a circle intersecting the east west line EW at E Divide EM at P such that $PM = EM/3$ Then with centre O and radius

¹ चतुरस्र मण्डल चिकीषन्नख्यार्थं मध्यात् प्राचीमध्यापातयेत्तदतिशिश्यते तस्य सह तृतीयं मण्डलं परिलिखेत् । —BSI 1 58

² चतुरस्र मण्डलं चिकीषन्मध्यात् कोणां निपातयेत् पार्श्वतः परिक्रम्यातिशयं तृतीयं सह मण्डलं परिलिखेत् । सानित्या मण्डलम् । यावद्वीर्यते तावदावतु । —ApSI 2

³ KSI 1 13

OP describe a circle This circle will be nearly equal in area to the given square *ABCD*

Let $2a$ denote a side of the given square and r the radius of the circle equivalent to it ; that is, $AB=2a$
 $OP=r$ Then

$$OA = a\sqrt{2},$$

$$\text{and } ME = (\sqrt{2} - 1)a$$

$$\text{Hence } r = a + \frac{a}{3} (\sqrt{2} - 1),$$

$$= \frac{a}{3} (2 + \sqrt{2})$$

Now according to the *Sulba*,¹

$$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3 \cdot 4} - \frac{1}{3 \cdot 4 \cdot 34}$$

$$= \frac{577}{408},$$

$$= 1 \cdot 4142156$$

$$\text{Therefore } r = a \times 1 \cdot 1380718$$

The area of the transformed circle, employing the value $\pi=3 \cdot 14159$, will be $4 \cdot 068987 \times a^2$ whereas the area of the given square is $4a^2$ Hence the former result is too large On the degree of equivalence of the area of the given square and of the circle into which it is transformed by the above rule, there is a noteworthy observation of Āpastamba He remarks,

sānityā mandalam yāvaddhīyate tāvadāgantu ²

According to the commentator Kapardisvāmī, the first word of this passage is a conjoint compound of the two

¹ Vide *infra*, p 189

² *ĀpŚl*, III, 2

words *sā* and *anītya*. So that the above should be rendered as It is an inexact (*anītya*) (method of construction) by as much the circle falls short so much comes in. He has been followed in this respect by Sundararaja. But the commentator Karavindasvami thinks that the correct reading of the passage will be *sa nītya mandalam* etc. According to this reading the observation appears to imply that the method of construction is an exact (*nītya*) one. But this commentator further thinks that the method has been called exact in a relative sense inasmuch as it yields a result more accurate than that obtained by any other method of circling the square known in the Āpastamba school. So he too finally comes to the same point of view as that Kapardisvami and Sundararaja.

Thibaut accepts as correct the reading of the text as given by Karavindasvami but has discarded his further explanation of the matter. So he renders the passage as

this line gives a circle exactly as large as the square for as much as there is cut off from the square (*vis* the corners of the square) quite as much is added to it (*vis* the segments of the circle lying outside the square).¹

Burk has closely followed Thibaut in this respect. The interpretation of Kapardisvami has been criticised by Thibaut thus.

But I am afraid we should not be justified in giving to Āpastamba the benefit of this explanation. The words *yavaddhiyate* etc. seem to indicate that he was perfectly satisfied with the accuracy of his method and not superior in this point to so many circle squarers of later times. The commentator who with the mathematical knowledge of his time knew that the rule was an imperfect one preferred very naturally the interpretation

¹ Thibaut *S. Itas t.* p. 26

which was more creditable to his author "1 Kapardīsvāmi explains that the remark *yāṭaddhiyate*, etc., implies only a nearer approximation but not exact equality

Now it may be pointed out that a similar remark, viz.,

csūnityā caturasra-karani

has been made by Āpastamba as regards his method for squaring the circle and which has been delivered by him immediately following the above one "2 The same remark is found also in the corresponding rule of Baudhāyana "3 Here Thibaut entirely agrees with the commentators in breaking up the first word *csūnityā* into *csū anityā*. But Burk falls out from him and takes the reading to be *csā nityā caturasra-karani*. Thus he has kept up the consistency of his opinion

It is truly very difficult to conjecture now correctly what was really implied by Āpastamba by that remark, whether he held that method of circling a square was an exact or an inexact one. We may be, however, sure to this extent that the interpretation of the orthodox commentators cannot be brushed aside as unlikely as is supposed by Thibaut

To transform a circle into a square

Baudhāyana says

" If you wish to square a circle, divide its diameter into eight parts, then divide one part into twenty-nine parts and leave out twenty-eight of these, and also the sixth part (of the preceding sub-division) less the eighth part (of the last) "4

1 *Ibid*, p 27

2 *ĀpŚl*, iii 3

3 *BSl*, i 60

4 "मण्डल चतुरस्रं विकीर्षन्विष्कम्भमष्टौ भागान् कृत्वा भागमेकीनविंशधा विभज्या-
ष्टाविंशतिभागानुद्धरेद्भागस्य च षष्ठमष्टमभागीनम् ।"—*BSl*, i 59

Thus if $2a$ denote the side of a square equivalent to a circle of diameter d then

$$2a = \frac{7d}{8} + \left[\frac{d}{8} - \left\{ \frac{28d}{8 \cdot 29} + \left(\frac{d}{8 \cdot 29 \cdot 6} - \frac{d}{8 \cdot 29 \cdot 6 \cdot 8} \right) \right\} \right]$$

$$\text{or } 2a = d - \frac{d}{8} + \frac{d}{8 \cdot 29} - \frac{d}{8 \cdot 29} \left(\frac{1}{6} - \frac{1}{6 \cdot 8} \right)$$

Since $d = 2r$ where r is the radius of the circle

$$a = r - \frac{r}{8} + \frac{r}{8 \cdot 29} - \frac{r}{8 \cdot 29 \cdot 6} + \frac{r}{8 \cdot 29 \cdot 6 \cdot 8}$$

This result was probably obtained from the previous one by inversion

$$r = \frac{a}{3} (2 + \sqrt{2})$$

$$\text{Therefore } 2a = \frac{3}{2 + \sqrt{2}} d$$

Substituting the value of $\sqrt{2}$ viz 577/408 we have

$$2a = \frac{1224}{1393} d$$

Thibaut supposes that Baudhayana then proceeded in the following way One eighth of 1393 = $174\frac{1}{8}$ this multiplied by 7 = 1218 $\frac{1}{8}$ Difference between 1218 $\frac{1}{8}$ and 1224 = $5\frac{1}{8}$ Dividing 174 (Baudhayana takes 174 in stead of $174\frac{1}{8}$ neglecting the fraction as either insignificant or more likely as inconvenient) by 29 we get 6 subtracting from 6 its sixth part we get 5 and adding to this the eighth part of the sixth part of six we get $5\frac{1}{8}$ In other words

$$174 = \frac{7}{8} + \frac{1}{8 \cdot 29} - \frac{1}{8 \cdot 29 \cdot 6} + \frac{1}{8 \cdot 29 \cdot 6 \cdot 8} \text{ of } 1393$$

(due allowance made for the neglected $\frac{1}{8}$) ¹

In the opinion of Cantor the series was probably obtained thus ¹

$$\frac{1224}{1393} = \frac{7}{8} + \frac{1}{8 \cdot 29} - \frac{1}{8 \cdot 29 \cdot 6} + \frac{1}{8 \cdot 29 \cdot 6 \cdot 8} - \frac{41}{8 \cdot 29 \cdot 6 \cdot 8 \cdot 1393}$$

The last term is nearly $\frac{1}{34}$ of the term preceding it and so may be neglected as being comparatively small. Hence, we get

$$2a = \frac{7d}{8} + \frac{d}{8 \cdot 29} - \frac{d}{8 \cdot 29 \cdot 6} + \frac{d}{8 \cdot 29 \cdot 6 \cdot 8}$$

Muller conjectures the procedure adopted to have been as follows ²

$$\begin{aligned} 2a &= \frac{3}{2+\sqrt{2}} d = \frac{3\sqrt{2}}{2\sqrt{2}+2} d = \frac{3}{2} \cdot \frac{\sqrt{2}}{1+\sqrt{2}} d, \\ &= \frac{3}{2} \cdot \frac{17-1/34}{29-1/34} = \frac{51-3/34}{58-2/34}, \end{aligned}$$

$$\text{since } \sqrt{2} = \frac{17}{12} - \frac{1}{12 \cdot 34} \quad \text{Now}$$

$$\frac{51-3/34}{58-2/34} = 1 - \frac{7+1/34}{58-2/34}$$

$$\frac{7+1/34}{58-2/34} = \frac{1}{8} \cdot \frac{56+8/34}{58-2/34} = \frac{1}{8} \left(1 - \frac{2-10/34}{58-2/34} \right),$$

$$\frac{2-10/34}{58-2/34} = \frac{1}{29} \cdot \frac{2-10/34}{2-2/34 \cdot 29} = \frac{1}{29} \left(1 - \frac{10/34-2/34 \cdot 29}{2-2/34 \cdot 29} \right)$$

$$\frac{10/34-2/34 \cdot 29}{2-2/34 \cdot 29} = \frac{5-1/29}{34-1/29} = \frac{1}{6} \cdot \frac{30-6/29}{34-1/29},$$

$$= \frac{1}{6} \left(1 - \frac{4+5/29}{34-1/29} \right),$$

¹ Cantor, *Geschichte*, I, p. 643

² C. Müller, *loc. cit.*, pp. 187 f

$$\frac{4+5/29}{34-1/29} = \frac{1}{8} + \frac{32+40/29}{34-1/29} = \frac{1}{8} \left(1 - \frac{2-41/29}{34-1/29} \right)$$

Thus we have

$$\begin{aligned} \frac{3}{4+\sqrt{2}} &= 1 - \frac{1}{8} + \frac{1}{8 \cdot 29} - \frac{1}{8 \cdot 29} \left(\frac{1}{6} - \frac{1}{6 \cdot 8} \right) \\ &\quad - \frac{1}{8 \cdot 29 \cdot 6 \cdot 8} \frac{2-41/29}{34-1/29} \end{aligned}$$

The last term may be neglected as being too small
Hence

$$2a = d - \frac{d}{8} + \frac{d}{8 \cdot 29} - \frac{d}{8 \cdot 29} \left(\frac{1}{6} - \frac{1}{6 \cdot 8} \right)$$

Alternative Method

Another method of squaring a circle has been taught by Baudhayana Apastamba and Katyayana. It has been explicitly admitted by all of them that this method yields only a gross (*antya*) value.

Or else divide (the diameter) into fifteen parts and remove two (of them). This is the gross (value of a) side of the (equivalent) square.¹

That is to say

$$2a = d - \frac{2}{15} d$$

$$\text{or} \quad a = r - \frac{2}{15} r$$

The *rationale* of this formula seems to be this.² Draw the square $ABCD$ circumscribing the circle and also the square $A'B'C'D'$ inscribed within it.

¹ *BSI* 69 § 1 *ApSt* : 3 *KSI* 14

² *Comp. Math.* 1 c t p 18

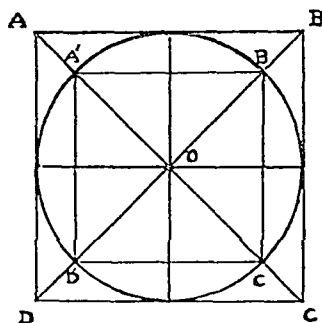


Fig 73

Then apparently, the area of the circle will be smaller than the area of the square $ABCD$ ($= 4r^2$) and greater than the area of the square $A'B'C'D'$ ($= 2r^2$), that is

$$4r^2 > \text{Area of the circle} > 2r^2$$

An obvious approximation will be

$$\text{Area of the circle} = \frac{4r^2 + 2r^2}{2} = 3r^2$$

If $2a$ denote a side of the square equivalent in area to the circle, we shall have approximately

$$4a^2 = 3r^2,$$

$$\text{or, } a = \frac{\sqrt{3}}{2} r$$

But, it will be shown later on¹

$$\sqrt{3} = 1 + \frac{2}{3} + \frac{1}{15} = \frac{26}{15},$$

up to the second order of approximation Therefore

$$a = \frac{13}{15}r = r - \frac{2}{15}r.$$

¹ *Infra*, p. 195

Dvarakanatha's Corrections

Dvarakanatha Yajñi has criticised with the help of specific examples the *Sulba* method of squaring a circle and its converse as yielding only approximate results. He has then proposed the following corrections to the ancient formulae ¹

$$(i) \quad r = \left\{ a + \frac{a}{8} (\sqrt{2} - 1) \right\} \left(1 - \frac{1}{118} \right)$$

$$(ii) \quad 2a = \left\{ d - \frac{d}{8} + \frac{d}{8 \cdot 2} + \frac{d}{8 \cdot 9} \left(\frac{1}{6} - \frac{1}{6 \cdot 8} \right) \right\} \\ \times \left(1 + \frac{1}{2} \frac{3}{133} \right)$$

By the formula (i) the area of the transformed circle will be nearly equal to $4.000344 \times a$ the value of π being taken to be 3.14159

Value of π

The above rules of the *Sulba* for squaring a circle and vice versa will work out the following values of π

$$(1) \quad \pi = \frac{4}{\left\{ 1 + \frac{1}{8} (\sqrt{2} - 1) \right\}^2} = 3.0883$$

$$(2) \quad \pi = 4 \left(1 - \frac{1}{8} + \frac{1}{8 \cdot 29} - \frac{1}{8 \cdot 29 \cdot 6} + \frac{1}{8 \cdot 29 \cdot 6 \cdot 8} \right) \\ = 3.0885$$

$$(3) \quad \pi = 4(1 - r_3)^2 = 3.004$$

It will be noticed that none of these values are fairly accurate as according to modern calculation $\pi = 3.14159$

In one instance Baudhāyana¹ has employed the value of $\pi=3$. A better value of π is found in the *Mānava Śulba*, which states that a square of two by two cubits is equivalent to a circle of radius 1 cubit and 3 angulis². Whence

$$(4) \quad \pi = 4\left(\frac{8}{9}\right)^2 = 3.16049$$

This value was given before by the Egyptian Ahmes (c. 1500 B.C.). With Dvāṛakanātha's corrections we have

$$\pi = \frac{4}{\left\{1 + \frac{1}{3}(\sqrt{2} - 1)\right\}^2} \left(\frac{118}{117}\right)^2 = 3.141109$$

$$\pi = 4 \left(1 - \frac{1}{8} + \frac{1}{8 \cdot 29} - \frac{1}{8 \cdot 29 \cdot 6} + \frac{1}{8 \cdot 29 \cdot 6 \cdot 8}\right)^2$$

$$\times \left(1 + \frac{1}{2} - \frac{3}{133}\right)^2$$

$$= 3.157991$$

Early History

It will be interesting to know the early history of the problem of the squaring of the circle and of its converse, the circling of the square, in India. Their origin dates, as has been noted before, earlier than the time of the *R̥g-veda* (before 3000 B.C.). That was in connection with the construction of the three primarily essential sacrificial altars of the Vedic Hindus, namely the *Gārhapatya*, *Āhavanīya* and *Dakṣināgni*. For these three altars had to be of the same area but of different shape, the first circular, the second square and the last semi-circular. Again, it has also been noted before, that

¹ “यूपवटा पदविक्षम्भा, विपदपरिणाहानि यूपोपराशीति।”—*BSI*, i. 112.3

² *MāŚI*, i. 27

Garhapatya altar may have according to certain authorities an alternative shape of a square besides its usual circular shape but retaining the same area. The earliest express reference to this tradition is found in the *Satapatha Brahmana* (c 2000 B C) ¹. It appears copiously in the Sutra works. From the latter we also learn of another ancient tradition that the *Dhunya*³ may be square or circular in shape but with the same area one square *pisila*. The form of an archaic variety of the *Smasana cit* (Fire altar of the shape of the cemetery) is stated to be circular according to some peoples and square according to others. As regards its size the *Satapatha Brahmana* after referring to the earlier opinions preferably approves of an area of one square *purusa* ⁴. Further instances of the early applications of the above problems are found in the *Taittiriya* and other *Samhita* (c 3000 B C) ⁵ in connexion with the construction of *Patha cakra cit Samuhya cit Paricayya cit* and *Drona cit* (alter native shape). In each of these cases one has to draw at first a square equal in area to that of the primitive *Syena cit* i.e. $7\frac{1}{2}$ square *purusas* and then that square has to be circled ⁶. This has been clearly described by Baudhayana⁷ and Apastamba⁸ and it was doubtless so

¹ SB vi 1 1 37

BSI 61 3 ApS xv 14 1 ApSI 56

³ BSI 73 ApS xv 21 5 ApSI 1 3 comp s ls
BSr v 6 29

⁴ SB 1 8 1 5ff

⁵ TS 5 4 11 ..

⁶ I of th Dr a t t nth f th t of med qu e
s fi tded t d a d th rema g t l p t t n fo m d
g n i t q d th n l d

⁷ BS 1 99 BSI 11 183

⁸ ApSI 1

before ¹ We occasionally meet with other instances of this kind in the earlier Hindu works ²

Burk has observed “ I shall only emphasize the fact that the Indians must have understood really in the time of the *Taittirīya Samhitā*, how to solve the problem of the *circling of the square* (although on very primitive methods) ’³

¹ Compare also Burk, *ZDMG*, LV, p 548

² *ĀpŚr*, xvi 4 7

³ *ZDMG*, LV, p 548

CHAPTER VII

SIMILAR FIGURES

It has been observed before that in the sacrificial rituals of the early Hindus it is oftentimes necessary to construct an altar differing in area from another by a specified amount. For instance the *Sautramaniki vedi* is stated to be equal to one-third of the *Mahavedi* and the *vedi* of the *Āśvamedha* double the latter. The *Lāṣa homa vedi* and *Kotihoma vedi* are respectively four and twenty five times the *Pakayajūṣi vedi*. Again it is said that the primitive Fire altar *Caturasra śyenacit* should have an area of seven and a half square purusas at the time of the first construction. At the second construction its area shall have to be $8\frac{1}{2}$ square purusas at the third $9\frac{1}{2}$ square purusas. In the same manner the area of the *Agni* should be increased by one square purusa at each successive construction up to $101\frac{1}{2}$ square purusas. The earliest reference to this mode of increment of the *Agni* as has been stated before is found in the *Satapatī Brahmana*. And the practice continued during the succeeding ages. Now it is the strict injunction of the *Śruti* that the primitive shape of the Fire altar must not be disturbed during the course of successive constructions.⁶

¹ BŚI 85 ApŚI 8 9 KŚ KŚI 19

² ApŚI 10 ApŚ 1. 9 1

³ M ŚI 6

⁴ ŚB 1. 3 6 ff

⁵ BŚI 1 ff ApŚ 17 15 16 ApŚI vi 3 4 KŚI 1 ff

⁶ Comp r wh t Ap t amb m k A b in th f m f
th Ag w uld b t th m juncti of the Śrut (ApŚI vi 6)
Acc d to Ś tap tī Br hm tho wh d p e th Ag f t
d p port w ll ff r the w fo 5 (3)

Consequently in the science of the altar-construction there arose the necessity of constructing similar figures

Now the shape of the *Mahāvedī* is that of an isosceles trapezium whose altitude is 36 *prakrama* (or *pada*), face 24 *prakrama* (or *pada*) and base 30 *prakrama* (or *pada*) Hence the *Sautrāmanikī-vedī* and the *vedī* of *Aśvamedha* will be of the shapes of isosceles trapeziums similar to it but in size one-third and double of it respectively Thus we have the two following propositions

(1) *To construct an isosceles trapezium similar to a given isosceles trapezium but with a third part of its area*

Construct an isosceles trapezium, says Āpastamba, in the same way as the given isosceles trapezium (*Mahāvedī*) but "with $1/\sqrt{3}$ of a *prakrama* being substituted for a *prakrama* therein, or with 8 and 10 times $\sqrt{3}$ as the transverse sides and 12 times $\sqrt{3}$ as the east-west line"¹ This will be the required isosceles trapezium (*Sautrāmanikī-vedī*)

For the area of the constructed figure

$$= \frac{36}{\sqrt{3}} \times \frac{1}{2} \left(\frac{24}{\sqrt{3}} + \frac{30}{\sqrt{3}} \right),$$

$$= \frac{1}{3} \times 18 \times 54 = 324 \text{ square purusas},$$

$$\text{or} \quad = 12\sqrt{3} \times \frac{1}{2} (8\sqrt{3} + 10\sqrt{3}),$$

$$= 324 \text{ square purusas}$$

Thus it is equal to one-third of the area of the given isosceles trapezium, which comprises 972 square purusas The same construction is suggested also by Kātyāyana²

¹ *ĀpŚI*, v 8

² *KŚI*, II 19

(ii) *To construct an isosceles trapezium similar to a given isosceles trapezium but with double its area*

The method of construction of the new isosceles trapezium will be the same says Āpastamba as that of the given isosceles trapezium but here $\sqrt{2}$ of a prakrama should be taken in the place of a prakrama therein ¹ That is taught also by Baudhayana ² Then the area of the new figure will be

$$= 36\sqrt{2} \times 4 (24\sqrt{2} + 30\sqrt{2}) \text{ square purusas} \\ = 1944 \text{ square purusas}$$

Hence it is double the size of the given trapezium (*Mahāveda*)

It is thus clear that the principle underlying the early Hindu method of construction of an isosceles trapezium similar to a given one but of n times the size of it n being integral or fractional is practically the same as that of the given one only the unit of measurement of the latter being replaced by another \sqrt{n} times it ³ This principle they adopted systematically for the construction of similar figures of more complicated shapes even when the change in the size does not bear a simple relation to the size of the given figure Thus arose the proposition

To construct a Fire altar similar to that of the shape of a falcon but differing from its primitive area of $7\frac{1}{2}$ square purusas by m square purusas

Baudhayana gives the following solution of this proposition

Divide that which is to be the difference from the original (given) size of the altar into 15 equal parts add

¹ ApSt	1
² BŚ	10
³ C mp	BŚ 19

to each of the (constituent) portions (*vidha*, that is, units) of the given figure two of these parts. Then construct a figure (in the same way as the given one) with $7\frac{1}{2}$ of these (altered) units " ¹

The geometrical operations to be followed in this method of construction are shortly these ². At first is drawn a square of an area equal to m square purusas. It is then divided into 15 equal parts. This may be done either by dividing one side of the square into 15 equal parts and then drawing lines parallel to the perpendicular sides, or by dividing one side into 3 parts and a perpendicular side into 5 parts and then drawing parallels. Two of the rectangular portions are then combined into a square and to that is again added a unit square purusa so as to form a third square. A side of this resulting square will be easily found to be $\sqrt{1 + 2m/15}$ purusas long. With this length as the unit, construct an altar in the same way as the original falcon-shaped altar. This will be the required figure. For its area will be

$$7\frac{1}{2} \times \left(1 + \frac{2m}{15} \right) \text{ or } \left(7\frac{1}{2} + m \right)$$

square purusas and its shape will be clearly similar to that of the given figure.

A similar method is taught briefly by Āpastamba.

" For the eight- and other-fold *Agnis*, that by which it differs from the area of the seven-fold (*Agni*), should be divided seven (and a half), then one part should be added to each (original) purusa " ³

" For the purpose of adding parts (in purusa) to the (seven-fold) *Agni* together with its wings and tail, take

¹ BŚI, II 12

² Compare also Thibaut's notes on the above

³ ĀpŚI, VIII 6

for the (new) puru a the (original) purusa increased by the seventh fold producer of the increment Then construct (in the same way as before) ¹

The method has been explained more fully by Katyayana His procedure is however slightly different from that of other writers Katyayana says

For the purpose of adding a square purusa (to the original falcon shaped *Agni*) construct a square equivalent (in area) to the original *Agni* together with its wings and tail add to it a square of one puru a Divide the sum (i.e. the resulting square) into fifteen parts and combine two of these parts into a square This will be the (new) unit of square purusa (for the construction of the required enlarged figure) ²

In other words the enlarged square unit is

$$\frac{2}{15} \left(7\frac{1}{2} + 1 \right) \text{ or } 1 + \frac{2}{15}$$

Or the new increased unit will be obtained thus says Katyayana

Divide a square of one purusa into five parts both ways (by lines drawn cross wise) combine five of the resulting elementary parts into a square subtract from the sum one third of it add the remainder to one square purusa This is another method (of determining the enlarged square unit) ³

¹ Ibid x 5 N t th d ff between the comm t to a a f
B k bout the t nterp t t n of th tw ul f Āp t amb
I th n k n th wh l th th do t p t t ont b m f d
con t t w th th nt t ion f th S t F uy th nterp t t n
w uld d t b th m l r ty f th l t r t cc c t t
wh h pre ly f b dd n

² KŚI 4

³ KŚI 6

That is, the enlarged square unit is

$$1 + \left(\frac{5}{5 \times 5} - \frac{1}{3} \frac{5}{5 \times 5} \right) \text{ or } 1 + \frac{2}{15}$$

square purusas. He gives a still third method

“ Or divide a square of one purusa into seven parts both ways (by lines drawn cross-wise), combine seven of the (resulting elementary) parts into a rectangle, subtract from the sum (a rectangle) $1\frac{1}{7}$ angulis by one purusa. Add the remainder to one square purusa. This is another method ” ¹

Thus it follows that the increased square unit will be

$$1 + \left(\frac{7}{7 \times 7} - 1 \times \frac{1\frac{1}{7}}{120} \right) \text{ or } 1 + \frac{2}{15}$$

square purusas, as before

If the number of square purusas (m) to be added to the original area of the *Agni* ($7\frac{1}{2}$ square purusas), be an exact multiple or submultiple of it, the geometrical operations are much simplified. For if $m = n \times 7\frac{1}{2}$, where n may be integral as well as fractional, then the length of the new unit will be easily obtained to be equal to $\sqrt{1+n}$ purusa. Thus it is the $(1+n)$ th *karanī* of a purusa, as has been stated by all the *Sulbakāras*.

This kind of increment is called *sarvābhyāsa* (or “ the increment by the whole ”) in contradistinction to the other which is called *purusābhyāsa* (or “ the increment by purusa ”) ²

¹ *KS*, v 8

² *KS*, v 2 3. These terms are sometimes used also in a different sense. According to it the first term signifies the increment of all the parts of the *agni* and the second only that of the complete puruṣas in the body, wings and the tail, but not the two aratnis and the *prādeśa* (*ĀpŚ* xxi 7, 10, *KS*, v 4)

The above principle of the enlargement of a *Vedi* or an *Agni* by increasing the length of the unit of measure but without altering the numbers representing the spatial magnitudes so as to keep the form similar to the original one is found as early as the *Satapatha Brahmana* (c 2000 B C) It says as large as the *Agni* (is to be made) so large (should be made) its units of measure and by so much one measures it in the same way (as before) To construct a *Vedi* 14 or $14\frac{2}{3}$ times as large as the *Mahavedi* and which will be similar to it this *Brahmana* says

As much this *vedi* of the seven fold Fire altar is making fourteen times so much one measures the *vedi* of 101 fold Or then he measures (by means of) a cord 86 prakramas long folds it into 7 equal parts of these three parts he adds to the east west line and throws out 4 Then he measures 80 prakramas folds them into 7 equal parts of these three parts he adds to the hind (transverse line) and throws out 4 Then he measures 24 prakramas folds them into 7 parts of these 3 parts he adds to the front (transverse line) and throws off 4 This then is the alternative measurement of the (enlarged) *Vedi*

Here two methods are to be discerned According to one it is required to construct a *vedi* 14 times as much while according to the other $14\frac{2}{3}$ times as much The operations implied are doubtless as follows The altar

¹ SB 1 3 11

² Ib d 3 7 10

³ Th t th M l d n wh h th p m m t e F lta d
l ged n p port to th f the l t r N w th e tw
p (r d f) g ds the m th d f con tr u t f th
m m m Fire lt Acc d to one th l t r b m 14 t m
the S pt d l Ag wh l accord n t th the 14 times Th
Mal r d s nl b d m th tw hool acc d gly

⁴ Egg ling xpl n tion (SBE V 1) XLIII pp 310 311 foot te)
bvion ly rro eous Th t will m k th d too gr t

builder should at first construct a square of sides 36 prakramas each. Fourteen such squares should be combined into a large square. A side of the resulting square, which is clearly equal to $36\sqrt{14}$ prakramas, is taken for the east-west line. Or otherwise a smaller square should be divided into the 7 equal rectangular portions by drawing lines parallel to a side of the square, the rectangle comprising three of these strips should be transformed into a square and then combined with the former larger square. A side of the resulting square, which will be easily recognised to be equal to $36\sqrt{14\frac{3}{7}}$ prakramas, is taken for the east-west line of the enlarged *vedi* to be constructed. By the same kind of operations, the face of the new *vedi* is obtained to be $24\sqrt{14\frac{3}{7}}$ prakramas and its base $30\sqrt{14\frac{3}{7}}$. So that the size of the new *vedi* will be $14\frac{3}{7}$ times that of the *Mahāvedi* and its shape similar to that of the latter.

The following method has been taught for the construction of a falcon-shaped Fire-altar, 14 or $14\frac{3}{7}$ times as large as the primitive one and similar to it.

“ Now the construction of (the enlarged forms of) the *Agni*. Twenty-eight (square) purusas are in front and twenty-eight (square) purusas behind, this is the body (of the *Agni*). Fourteen (square) purusas form the southern wing, fourteen the northern wing and fourteen the tail. Fourteen *aratnis* (meaning, a length equal to the side of a square comprising fourteen square *aratnis* (i.e., $\sqrt{14}$ *aratnis*) is added to the southern wing, fourteen *aratnis* to the northern wing, and fourteen *vitastis* (meaning, a length equal to the side of a square of fourteen square *vitastis*, i.e., $\sqrt{14}$ *vitastis*) to the tail. This is the measurement of (the *Agni* of) 98 square purusas with a little excess (due to the increment of the wings and the tail). Or again

he measures (by means of) a cord three purusas folds it into seven (equal) parts of them four parts he adds to the body and three to the wings and tail Then he measures an aratni folds it into seven parts of them three parts he adds to the southern wing three to the northern wing and throws off one ¹ Then he measures a vitasti folds it into seven parts of them three parts he adds to the tail and throws out four Thus is constructed the 101 fold (Agni) and it corresponds with the *vedi* of this

The geometrical operations intended to be performed in this case are similar to those indicated in the previous case Here also are to be discerned two methods for the construction of the *Ekaśata vidha Agni* or the Fire altar of 101½ square purusas According to the first method each unit of measure is $\sqrt{14}$ times the unit of measure employed in the construction of the primitive Fire altar of 7½ square purusas while according to the other probably the more ancient one it will be $\sqrt{14^3}$ times Though the principle of similarity of shapes is perfectly maintained in either methods as regards the size they of course yield only approximate results For $7\frac{1}{2} \times 14 = 105$ square purusas $7\frac{1}{2} \times 14^3 = 108\frac{3}{4}$ square purusas The rationale of these results we shall indicate in the next chapter We should but note here that as the second method ³ yields a result more deviating from the correct and desired one viz 101½ square purusas its

¹ The part of the body that remains of the body was the middle part

² SB 3.11.14 Egg 1 g r n d r g o

³ The second method is a method by which the body is enlarged by the method of the first method. So that the body by the method of the first method is enlarged by the method of the first method.

correctness was challenged even before the time of the *Satapatha Brāhmaṇa* (c 2000 B C)

“ As to this they say, ‘as seven¹ (square) purusas have exceeded, how is it that they do not deviate from the right total (*sampad*, which the altar ought to have) ’ ”

The change of the representative number is strictly forbidden in this work, as that will disturb the principle of similarity of the forms It observes

“ Now some intending to construct subsequent (larger) forms (of the *Agni*), increase (the number of) these prakramas and vyāmas, supposing, ‘ we shall enlarge the womb (*yoni*) accordingly ’ One should not do so, for the womb does not increase along with the child that has been born, but indeed only as long as the child is within the womb, so long does the womb enlarge, and this much again is the growth of the child here Those who do it in that way, certainly do they deprive this Father Prajāpati of his perfection (*sampad*, that is, due proportions) ” ²

In the foregoing methods of enlargement of the original size of an altar, it will be observed, all the constituent parts of it receive increments in equal proportions But sometimes an altar, particularly the falcon-shaped one, is enlarged on an entirely different plan According to

¹ The printed text has *trayodasa* or “ thirteen ” It seems to be a mistake For it was intended to construct a Fire altar having an area equal to $101\frac{1}{2}$ square purusas Now the method adopted produces one with an area of $108\frac{3}{4}$ square purusas So $108\frac{3}{4} - 101\frac{1}{2}$ or $6\frac{5}{4}$ square purusas are in excess In round numbers this might be stated as equal to 7 square purusas But “ thirteen ” cannot be justified So I think that here again the text should be amended to *sapta* or “ seven ”

² *ŚBr*, x 2 3 6 7 In this metaphor, the *Agni*, as usual, is called the Father Prajāpati, his child is the unit of measure employed, and the womb is his form and hence the numbers representing the spatial relations of that form (*cf* *ŚBr*, viii 6 3 12, x 2 3 3) This passage has been referred to in the aphorism vi 4 of the *Kātyāyana Śulba*

it certain parts of the altar such as the complete purusas in the body wings and tail of the falcon are enlarged proportionately while the rest the two aratnis and the pradeśa by which the wings and tail were lengthened fundamentally are left unaffected This plan of enlargement of the falcon shaped altar has been noticed by all the three principal Sulbakaras It is particularly advocated by the tradition of one school as necessary for the altar of the Horse Sacrifice Other schools however follow the general plan of proportionate increment of all parts in that case too ¹

We have so far considered the construction of figures particularly isosceles trapeziums similar to a given one and differing from it in area by a specified amount It is sometimes also necessary to construct a figure similar to another and having a given side For instance the *Ekadaśinī vedī* is stated to be similar to the *Mahavedī* and is indeed an enlarged form of it It is so called because it must have according to the injunction of the scriptures eleven (*ekadāśa*) sacrificial posts (*yupa*) in front It is further prescribed that the two posts on either sides of the middle one must be at a distance of one *akṣa* (=104 *anṇulis*) and four *anṇulis* from it and the rest are an *akṣa* distant from each other Each post has a diameter of one *pada* Hence the east side of the *Ekadaśinī vedī* is 10 *akṣas* 11 *padas* 8 *anṇulis* long Thus it is required to construct an isosceles triangle similar to the *Mahavedī* and having its base equal to this length Again according to Baudhayana the shape of the *Āśtamedha vedī* is similar to the *Mahavedī* and has 21 *yupas* on the east side that is has a base of 20 *akṣas* 21 *padas* 8 *anṇulis* long

¹ *BSI* 8 ff 3 13 *ĀpS* 6 10 *KS* 7

² *BSI* 106 ff

The method of construction to be adopted in these cases is indicated by Baudhāyana thus

“ For that (*Ekhādaśinī vcdi*) take the twenty-fourth part of 10 aksas 11 padas 8 angulis, this will be the prakrama and with this (altered unit), the *vcdi* has to be constructed (in the same way as the *Mahāvedī*) ”¹

“ For the *Aśvamedha-vcdi* take the twenty-fourth part of 20 aksas 21 padas 8 angulis, this will be the prakrama and with this (modified unit), the *vcdi* has to be constructed (in the same way as the *Mahāvedī*) ”²

The face, base and altitude of the *Mahāvedī* are given respectively to be 24, 30 and 36 prakramas in length. If a, b, c be the corresponding quantities of a similar figure, we shall have

$$\frac{a}{24} = \frac{b}{30} = \frac{c}{36},$$

$$b = 30\left(\frac{a}{24}\right), \quad c = 36\left(\frac{a}{24}\right)$$

This is equivalent to the change of the ordinary unit to $a/24$ times it, where a is the given length of the face of the figure to be constructed.

A similar method will have to be followed in constructing an isosceles trapezium similar to a given one and having a given altitude³

These methods are also taught by Kātyāyana⁴

It may be noted that Āpastamba's method of construction of several altars by employing the rational rectangle (15, 36, 39) by successively varying the units, is obviously equivalent to the construction of a system

¹ *BŚI*, i 107, *vide* also *BŚr*, xxvi 23

² *BŚI*, i 108, *vide* also *BŚr*, xxvi 10

³ *BŚI*, i 109 10

⁴ *KŚI*, vii 1-3, compare *KŚr*, viii 8 22

of rectangles similar to it. Indeed the science of the altar construction requires the drawing of (a system of) similar rectangles triangles rhomboids circles and other figures. For the enlargement of altars of those shapes involves it.

CHAPTER XIII

GEOMETRICAL ALGEBRA

The geometrical constructions described in the preceding chapter are of considerable algebraic significance. They indeed form the seed of the Hindu *geometrical algebra* whose developed form and influence we notice as late as in the *Bhāṣana* of Bhāskara II (born 1114 A D). The first plan of enlargement of a figure in which all the constituent parts are affected in equal proportions, leads to the quadratic equation of the type

$$ax^2 = c$$

The second plan leads to the complete quadratic equation

$$ax^2 + bx = c$$

Let x denote the length of the enlarged unit of purusa and m denote the total increment in area. Then, in the case of the enlargement of the *isosceles trapezium* on the first plan, we shall have

$$36x \times \left(\frac{24x + 30x}{2} \right) = 36 \times \left(\frac{24 + 30}{2} \right) + m,$$

$$\text{or } 972x^2 = 972 + m$$

Therefore
$$x^2 = 1 + \frac{m}{972}$$

Hence
$$x = \sqrt{1 + m/972}$$

If $m = 972(n-1)$, so that the area of the enlarged trapezium is n times its original area, we get

$$x = \sqrt{n}$$

as given in the *Sulba*. The particular cases, when $n =$

14 or 14, are found as early as the *Satapatha Brahmana* (c 2000 B C) ¹

For the enlargement of the *falcon shaped Fire altar* on the *first plan* we get the quadratic equation

$$2x \times 2x + 2 \left\{ x \times \left(x + \frac{x}{5} \right) \right\} + x \times \left(x + \frac{x}{10} \right) = 7\frac{1}{2} + m$$

or
$$\frac{15}{2}x^2 = 7\frac{1}{2} + m$$

Therefore
$$x = 1 + \frac{2m}{15}$$

Hence
$$x = \sqrt{1 + \frac{2m}{15}}$$

In particular when $m=94$ that is when the Fire altar has its maximum enlargement permissible under the *Sulba* we have

$$x = 13\frac{8}{15} = 14 \text{ approximately}$$

as found in the *Satapatha Brahmana* (*vide supra*)

In the case of the enlargement of the *falcon shaped Fire altar on the second plan* the geometrical operations are equivalent to the solution of the following complete quadratic equation

$$2x \times 2x + 2 \left\{ x \times \left(x + \frac{1}{5} \right) \right\} + x \times \left(x + \frac{1}{10} \right) = 7\frac{1}{2} + m$$

$$\text{or } 7x^2 + \frac{1}{2}x = 7\frac{1}{2} + m$$

Completing the square on the left hand side we get

$$(7x + \frac{1}{4}) = \frac{841}{16} + 7m$$

¹ SB x 3 7 ff V d pr pp 159 f

Therefore
$$x = \frac{1}{28}(\sqrt{811 + 112m} - 1), \quad (1)$$

$$= \frac{1}{28} \left\{ 29 \left(1 + \frac{56m}{811} \right) - 1 \right\},$$

$$= 1 + \frac{2m}{29},$$

neglecting higher powers of m Therefore we have

$$x^2 = 1 + \frac{4m}{29}, \text{ approximately,} \quad (2)$$

Kātyāyana says

“Or for the second and following constructions, increase (the usual unit of) the (square) prakrama by itself for every seven constructions, so that (at each successive construction) take for the prakrama, the original value of the prakrama enlarged by its one seventh”¹

So that, according to him, the enlarged unit (x^2) will be

$$x^2 = 1 + \frac{m}{7}, \quad (3)$$

whereas a more accurate value has been proved above to be

$$x^2 = 1 + \frac{m}{7\frac{1}{4}}, \text{ approximately,} \quad (21)$$

In particular, when the Fire-altar has its maximum enlarged form of $101\frac{1}{2}$ square puruṣas, we have

$$7\frac{1}{2} + m = 101\frac{1}{2}$$

Substituting in (1), we get

$$x = \frac{1}{28}(\sqrt{11369} - 1)$$

Hence
$$x^2 = \frac{1}{784}(11370 - 2\sqrt{11360})$$

Now
$$\sqrt{11360} = 106 + \frac{1.3}{212} \text{ approximately}$$

Therefore
$$\begin{aligned} x^2 &= \frac{1}{784} \left(11156 + \frac{79}{100} \right) \\ &= 14 + \frac{19159}{83104} \\ &= 14 + \frac{3}{13 \frac{245}{13150}} \end{aligned}$$

Hence
$$x = 14 + \frac{3}{13} \text{ approximately} \quad (4)$$

Katy yana gives a nearly equal value

$$x^2 = 14 + \frac{3}{7} \quad (5)$$

He says

The side which turns out a square of the area four teen and three sevenths (square) prakramas will be the length of the prakrama for the 101 fold (Fire altar) ¹

It is not at all easy to determine the *rationality* of Katyayana's formula (3) and (5) whether they were obtained in the way indicated above by the method of the solution of a complete quadratic equation or in any other way. It is found that there are discrepancies between the results calculated by the former method and those found in the extant copies of the manuscripts of his works. How to explain them? Whether by the crudeness of his method of solving the quadratic equation or of the

calculations attendant on it,¹ if he had at all followed that method, or in any other way? Now the discrepancy need not be considered very serious in the general case, especially if we remember the degree of accuracy that can be naturally expected in those early times, or that is ordinarily found to have been followed then. Even in modern times 7 will be considered to be a very fair approximation to $7\frac{1}{2}$. What will appear to be serious is in the other case which requires an emendation of the existing text in order to explain away the discrepancy with the result calculated as above. But, we would remark, that by itself should not be considered a very formidable objection against our hypothesis as regards the method of Kātyāyana. For those who have dealt with ancient manuscripts are quite aware that they doubtless require emendations here and there. That discrepancy can be explained away much more easily and reasonably by supposing that the result (5) was derived from the modified result (3) by substituting the value, $m = 94$, but was not calculated directly from the equation (1) as we have done above.

It should be noted that the relevant portions of the existing manuscripts of the *Kātyāyana Śulba* might be considered to be quite correct and his results extremely accurate if we follow a certain interpretation of the text. Let us suppose that (1) the term *śaśata-vidha* means "the construction (of a Fire altar having an area) of 101

¹ It should be noted that the result (4) does not follow, quite contrary to expectations, from the equation (2), on the substitution in the latter of the value, $m=94$

$$x^2 = 1 + \frac{4 \times 94}{29} = 13 \frac{28}{29} = 14, \text{ approximately}$$

This is too less than the value (5) recorded by Kātyāyana. That is why we started by substituting $m=94$ in the equation (1). This shows that the process of calculation has much to account for

(square purusas) and (2) that the area of 101 square purusas comprises only the complete purusas in the altar not including the two aratnis and the pradeśa. Then the algebraic representation of the second method of enlargement of the primitive falcon shaped Fire altar will be

$$7x = 7 + m$$

Therefore
$$x = 1 + \frac{m}{7}$$

And in the particular case of the maximum enlargement we shall have

$$7x = 101$$

Hence
$$x = 14 \frac{3}{7}$$

Thus the results come out exactly to be the same as are found in extant MSS. According to this interpretation the construction of the enlarged altars does not even involve the solution of the complete quadratic equation.

We shall now proceed to examine how far the above interpretation can be held to be correct. It should be opposed mainly on three grounds. *Firstly* the supposed interpretation of the term *ekāśata vidhā* as meaning the construction of a Fire altar of an area of 101 square purusas is very unusual. Indeed according to all the *Sulba* and also the *Satapatha Brahmana* that term must always refer to an area of $101\frac{1}{2}$ square purusas. Similarly it is known that *sapta vidhā* always refers to $7\frac{1}{2}$ square purusas, *asta vidhā* to $8\frac{1}{2}$ square purusas and so on. *Secondly* for that interpretation the stipulated area of 101 square purusas has been assumed to be comprised of the area of the complete purusas in the body wings and tail of the falcon shaped Fire altar in exclusion of the two aratnis and the pradeśa in the latter. Therefore in that case the area of the complete altar all told will be greater than $101\frac{1}{2}$ square purusas. But the maximum extent up to

which the Fire-altar is sanctioned to be enlarged by successive constructions is $101\frac{1}{2}$ square purusas Thus Baudhāyana expressly remarks

“ The first (īc, when constructed for the first time) Fire-altar has an area of seven and a half square purusas The second contains eight and a half, the third, nine and a half In this way, the addition of one purusa takes place at each successive construction up to the *ekaśata-vidha* (īc, ‘ the construction including an area of $101\frac{1}{2}$ square purusas ’) After that, the *ekaśata vidha Agni* should be repeated (without making any further enlargement of it) Or else the sacrifice should be performed without an *Agni* ”¹

Satapatha Brāhmaṇa says

“ Some say, ‘*eka-vidha Agni* should be constructed first, then by an increment of one (square purusa) successively up to a construction of unlimited size ’ One should not do so The *Prajāpati* (īc, *Agni*) was created first as *sapta-vidha* indeed Proceeding to reconstruct himself, he stopped at the *ekaśata-vidha* (‘ a construction comprising $101\frac{1}{2}$ square purusas ’) He who constructs (a Fire-altar) smaller than the *sapta-vidha*, cuts asunder this *Prajāpati* he voluntarily becomes a sinner as one would be by destroying or injuring his better Again one who constructs (a Fire-altar) exceeding the *ekaśata-vidha*, he proceeds beyond all these (visible Universe), for the *Prajāpati* is this Universe Hence one should first construct the *sapta vidha* and then by the increment of one (square purusa) in succession up to the *ekaśata-vidha* But one should not construct in excess of the *ekaśata-vidha* Thus he

¹ BŚI, II 1-7 Compare also ĀpŚI, VIII 3, KŚr, XVI 8 25, KŚI, V 1, VI 4, ĀpŚr, XVI 17 15 6 In this last work Āpastamba has expressly referred to the tradition of the Vājasaneyya school (īc, to the *Satapatha Brāhmaṇa*) on this point (vide below)

neither cuts asunder the latter *Prajapati* nor does he proceed beyond all these (the Universe) ¹

So the above interpretation stands in direct contradiction with the injunctions of the early scriptures

Thirdly the practice of the mention of an altar by reference to the area of a part of it as has been supposed for the above interpretation is unknown in the *Sulba* and earlier literatures of the Hindus. Thibaut once thought that such a thing had been implied in a certain rule of Baudhayana. He says: But according to the above *sutra* and its commentary the *Āśvamedhī* *Agni* was of a different nature. It had to comprise twenty one *puruṣas* not including the lengthening of the two wings by one *aratni* each and of the tail by one *pradeśa* so that its *atman* consisted of twelve square *puruṣas* its wings and tail of three *puruṣas* each. A proportional increase of the two *aratnis* and the *pradeśa* would amount to 1½ square *puruṣas* and then the *agni* would no longer be *ekavimśa* as the *śruti* demands. Therefore the wings were lengthened only by the regular *aratni* (of 24 *angulis*) and the tail by the regular *pradeśa* (12 *angulis*) so that the increase of the *agni* caused thereby remained less than one square *puruṣa* and the *agni* preserved its character of *ekavimśa*. ² Thibaut has been followed in this matter by Burk. ³ They are clearly in error. ⁴ For the *sutra* they had in view says absolutely nothing about the actual size of the *Āśvamedhī* *Agni*. The commentator *Dvarakanatha*

¹ *SB* x 23 178

² Th. ref. c. 1. 11. w. 1. 11. B. d. y. *Sulb*
(3-1) आश्वमेधिक्रियायै पुरुषाभ्यासी नारदिविद्वान्शानाम् ।

T P d t N w Ser V 1 I p 769

ZDMC LXI pp 305 ff

³ Eg. h. w. w. n. ppos. th. t. k. e. ign. m. n.
It m. as. n. tw. ty. m. n. l. oth. n. ach. f. th. lo. r. des. of
t. body (*SB* V p 304 f.)

Yajñi truly took the area of the fire altar to be $21\frac{1}{2}$ square puruṣas. His use of the *dukarani* of a puruṣa in the construction can be more easily and satisfactorily explained in a way different from that supposed by Thibaut and Burk.

Now as regards the size of the *Āśvamedhika Agni*, Kātyāyana states clearly "(It) is twice or thrice (the area of) the primitive *agni* or twenty onefold (*ekavimsatidha*)"¹ Such is also the opinion of the other *Sulba* *kīras* as well as of the *Brāhmaṇa*.² *Śatapatha Brāhmaṇa* mentions also of a particular school, according to which the total area of the altar should be $12\frac{1}{2}$ square puruṣas.³ As regards the method of enlargement of the primitive falcon-shaped altar of $7\frac{1}{2}$ square puruṣas by which we are to arrive at the construction of the altar for the Horse Sacrifice having the specific area sanctioned for it by the scriptures, one school advocates the proportional enlargement of every part of the construction, while another school the similar enlargement of only those parts which comprise the complete puruṣas, excluding the two *aratnis* in the wings and the *prūdesū* in the tail. For an altar with an area of 15 or $22\frac{1}{2}$ square puruṣas enlarged on the first plan we shall have it will be easily found, to take the *dukarani* or *trikarani* of a puruṣa and proceed in the same way as in the construction of the primitive *Agni*. For an altar with an area of $21\frac{1}{2}$ square puruṣas enlarged, but according to the second plan, the algebraic equation will be

$$7x^2 + \frac{1}{2}x = 21\frac{1}{2}$$

Therefore $x = \frac{1}{28}(\sqrt{2409} - 1)$

¹ *KŚr*, xx 4 15, *KŚl*, v 2 3

² *BŚl*, iii 8 ff., iii 321 ff., *ĀpŚl*, xxi 6, 9, *ĀpŚr*, xx 9 1, *SBr*, xiii 3 3 7 ff.

³ *SBr*, xiii 3 3 9

$$\begin{aligned}
 \text{Hence } x &= \frac{1}{784} (2410 \pm 2\sqrt{2100}) \\
 &= \frac{1}{784} \left(2410 \pm 2 \times 45\frac{1}{49} \right) \text{ approximately} \\
 &= 3 \pm \frac{193}{2401}
 \end{aligned}$$

Therefore we may take as a very near approximation $x = 3$. And that is what Dvarakanatha Jayana has done.¹ We do not think it to be fair to him to interpret him otherwise as Fribaut does.

For the above reasons we discard this latter interpretation of Katyayana's rules and hold that the construction of altars enlarged according to the second plan noted above and which is used to be followed in a certain school of the *Brahmana* does undoubtedly depend preliminarily on the solution of the complete quadratic equation

$$ax^2 + bx = c$$

and further that Katyayana's results were obtained in this way. Milhaud is stated to have arrived at the former conclusion before. His article is unfortunately not available to me and so I do not know the arguments adduced by him.

It may be noted that the commentator Mahabhāṣya is of no help to us about this knotty point of the enlargement of the Fire altar. According to his interpretation of

¹ W. B. D. by the m. It from the q. t. () For p. the g. m. = 14 (= 1½ - 7½) t. w. g. t.

$$x = 3 \pm \frac{193}{2401} \approx 3 \quad \text{ly}$$

² G. M. h. d. L. G. métr. d. Ap. t. mb. Re. g. t. ? d. S. nce. XXI 1910 pp. 51-50. qu. t. d. by Pr. fe. o. D. E. Smith. h. H. t. u. f. M. th. m. t. V. l. II p. 411 fn.

Kātyāyana's rules, the area of the Fire altar after an increment of m square puruṣas will be $7\frac{1}{2} \times \left(1 + \frac{m}{7}\right)$ square puruṣas. This interpretation evidently assumes a proportional enlargement of all the constituent parts of the primitive Fire altar and hence should be discarded as being directly against the express intention of the *Sulba*. Another objection against it will be that the area of the Fire-altar at the final construction (the ninety-fifth construction) according to it will be $7\frac{1}{2} \times \left(1 + \frac{94}{7}\right)$ or $108\frac{3}{11}$ square puruṣas and hence much in excess of the maximum enlarged area viz., $101\frac{1}{2}$ square puruṣas, permissible under the *Sulba*. Weber¹ informs us that such a method of enlargement of the Fire altar is found in the *Paddhati* of Yājñikadeva. Its origin seems to be in the *Satapatha Brāhmaṇa*². But it was criticised and challenged even then³. I cannot give the opinion of the commentator Rāma on this point as the relevant portion of his commentary is not available to me at present.

The solution of the quadratic equation in its simpler forms is required in connexion with the enlargement of altars followed in a different school. According to that school, we are informed,⁴ the altars with areas $1\frac{1}{2}$, $2\frac{1}{2}$, $6\frac{1}{2}$ square puruṣas should be of the square form. So it will then be necessary to construct a square differing from another by a specified quantity. Now we find in the

¹ A. Weber, *Indische Studien*, XIII, p. 240 f.

² *SBr*, x 2 3 11-14.

³ *SBr*, x 2 3 15 6.

⁴ *BŚI*, iii 319,

Sulba the following general rule for the enlargement of a square

Add on the two sides (of the given square) those (two rectangles) which are described with as much as the increment (of the side of the square) and its side add further at the corner the square which is produced by that increment ¹

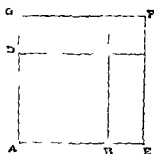


Fig 74

Let $ABCD$ be the given square. Suppose its side is to be increased by the amount BE say. Add to the sides BC and DC two rectangles CE and CG each of which is equal to $AB \cdot BE$. Also add at the corner C the square CF equal to the square on the increment BE of the side AB . Then $AEFG$ is the square on the enlarged side AE .

This is the analogue of the algebraic identity

$$(a+b)^2 = a^2 + 2ab + b^2$$

Now we shall apply this result to enlarge a square of area a by m square puruṣas say. If x be the increment of a side then by the above rule

$$x^2 + 2ax = m$$

$$\text{or } x^2 + 2ax + a^2 = a^2 + m$$

¹ *ĀpŚi* 2 C mp r 1 *BŚi* 19 4

Therefore $x = \sqrt{a^2 + m} - a$

The geometrical method of the transformation of a square (c^2) into a rectangle having a given side (a), which has been described before is obviously equivalent to the solution of the linear algebraic equation,

$$ax = c^2$$

CHAPTER XIV

INDETERMINATE PROBLEMS

In the *Sulba* we find the solution of certain very interesting indeterminate problems. Some of them follow directly from the geometrical constructions made therein others have been tacitly assumed for that purpose. We shall here notice the more important ones amongst them.

Rational Right angled Triangles

The formula of Katyayana to find the sum of n equal squares of sides a each amounts to

$$a(\sqrt{n}) + a^2\left(\frac{n-1}{2}\right) = a\left(\frac{n+1}{2}\right)$$

Putting m for n in order to make the sides of the right angled triangle free from the radical and dividing out by a^2 we get

$$m^2 + \left(\frac{m^2-1}{2}\right)^2 = \left(\frac{m^2+1}{2}\right)^2 \quad (I)$$

as the solution of the indeterminate equation of the second degree

$$x^2 + y^2 = z^2 \quad (A)$$

If the sides of the right angled triangle are to be integral as well as rational m must be odd. According to Proclus (c 450 A D) this solution was known to Pythagoras (c 540 B C).

A still more general solution of (A) which includes the solution (I) as a particular case is furnished by the

method of transformation of a rectangle into a square It is this

$$\left(\sqrt{mn} \right)^2 + \left(\frac{m-n}{2} \right)^2 = \left(\frac{m+n}{2} \right)^2,$$

where m, n are any two arbitrary numbers Substituting p^2, q^2 for m, n respectively, in order to eliminate the irrational quantities, we get

$$p^2q^2 + \left(\frac{p^2-q^2}{2} \right)^2 = \left(\frac{p^2+q^2}{2} \right)^2 \quad (\text{II})$$

A further generalisation has been tacitly assumed in some methods employed by Āpastamba for the construction of the *Mahāvedī* If the sides of a rational right triangle are known, then other rational right triangles can be obtained by multiplying them by any rational integer, or how he puts it, by increasing them by any rational multiples of them Thus if α, β, γ be a rational solution of $x^2 + y^2 = z^2$, then other rational solutions of it will be given by $l\alpha, l\beta, l\gamma$ where l is any rational number This is clearly in evidence in the formula of Kātyāyana It is now known that all rational solutions of (A) can be obtained without duplication in this way

Karavindasvāmī gives the solution,¹

$$x, \left(\frac{m^2+2m}{2m+2} \right)x, \left(\frac{m^2+2m+2}{2m+2} \right)x$$

It can of course be derived from the solution (I) by multiplying by x and dividing by m^2 every element of it and then putting $m+1$ for m

Rational Right Triangles having a Given Leg

There seems to have been an attempt to find the rational right triangles having a given leg We find in

¹ Vide his commentary on *ĀpŚI*, 1 §4

the *Sulba* at least two such right triangles having a common leg a viz

$$(a \ 3a/4 \ 5a/4) \text{ and } (a \ 5a/12 \ 13a/12)$$

The principle underlying these solutions will be easily detected to be that of the reduction of the sides of any rational right triangle in the ratio of the given leg to the corresponding side of it. Thus the sides of a rational right triangle having a given leg a will be $(a \ a\beta/\gamma \ a\gamma/\gamma)$ where $\beta \ \gamma$ are the sides of any rational right triangle. So that starting with the solution (II) we shall find that all rational right triangles having the leg a will be given by

$$a \left(\frac{p^2 - q}{2pq} \right) a \left(\frac{p^2 + q}{2pq} \right) a$$

But this general solution is not stated anywhere in the *Sulba*. The commentators of *Apastamba* however give the solution

$$a \left(\frac{m + 2n}{2m + n} \right) a \left(\frac{n^2 + 2m + 2}{2n + 2} \right) a$$

It should be noted that the above principle for obtaining the rational right triangles having a given leg has been followed expressly in later times in India by Mahavira (850) and in Europe by Leonardo Fibonacci of Pisa (1200) and Vieta (c. 1580)

Simultaneous Indeterminate Equations

The construction of the *vedi* gives rise to a type of problems of indeterminate character though in a few cases the physical conditions are so prescribed as to make them determinate.¹ For instance the breadth of the *Garhapatya*

¹ S. B. Bhatt: *bbh. s. D. tt. Th. Or. g. f. H. d. I. det. m. t.*
A. lys. Ar. f. n. XII (1931) pp. 401-40

vedi shall have to be, according to the tradition of the scriptures, one *vyāyāma* ¹ But its form should be square according to some and circular according to others ² It is to be constructed with five layers of bricks, each layer consisting of 21 bricks Further the rifts of bricks in two consecutive layers must not coincide The shape of the bricks employed may be square or rectangular Now the most interesting case is that in which the *vedi* and also the bricks employed in constructing it, are square in shape It is said that three kinds of square bricks should be made with the sixth, fourth and third part of a *vyāyāma* as a side The first layer (l_1) should be constructed with 9 bricks of the first kind and 12 bricks of the second kind, and the second layer (l_2) with 5 bricks of the third kind and 16 bricks of the first kind ³ That is, if we denote the bricks of different kinds thus $b_1 = v^2/36$, $b_2 = v^2/16$, $b_3 = v^2/9$, where v denotes a *vyāyāma*, then

$$l_1 = 9b_1 + 12b_2, \quad l_2 = 5b_3 + 16b_1$$

The third and fifth layers are replica of the first and the fourth, of the second

Now it may be asked how the ancient altar-builders determined the size of the bricks of different kinds and the number of bricks of each kind that will be required for the construction of each layer They proceeded probably in some way like this Since 21 is not a square number, no layer of the altar can be constructed with bricks of the same kind So the number of kinds of bricks employed in any layer must be at least 2 Since no two successive layers should have identical cleavage, all the bricks

¹ *BŚI*, II 61, *ĀpŚI*, VII 5, compare also *ĀpŚI*, VII 10

² *BŚI*, II 62 3, *ĀpŚI*, VII 6

³ *BŚI*, II 66 9

employed in the second layer must not be the same as those of the first layer. Hence the minimum kinds of bricks must be 3. Assume then their sides to be p , q and r th part of a *vayama* where p , q , r are rational integers to be determined. Suppose the first layer consists of x bricks of the first kind and y bricks of the second kind. Then we must have

$$\frac{x}{p^2} + \frac{y}{q^2} = 1$$

$$x + y = 21$$

Similarly if the second layer consists of u bricks of the third kind and v bricks of the first kind

$$\frac{u}{r^2} + \frac{v}{p^2} = 1$$

$$u + v = 21$$

Thus we are led to the simultaneous indeterminate equations

$$\left. \begin{aligned} \frac{x}{m} + \frac{y}{n} &= 1 \\ x + y &= 21 \end{aligned} \right\} \quad (A)$$

Baudhayana's statements about the size of the different varieties of bricks and the number of them employed in the construction of a particular layer amount to the following solutions of the equations (A)

$$\left. \begin{aligned} m &= 6 & x &= 9 \\ n &= 4 & y &= 12 \end{aligned} \right\} \quad \left. \begin{aligned} m &= 8 & x &= 5 \\ n &= 6 & y &= 16 \end{aligned} \right\}$$

These solutions were probably obtained by trial in succession thus. Solving (A) as simultaneous linear equations in x and y we get

$$x = \frac{n(21-n)}{m-n}$$

$$y = \frac{n(m-21)}{m-n}$$

Now the physical circumstances of the problem are such that x and y must be positive integers. Therefore if $m > n$

$$m^2 > 21 > n^2$$

$$\text{or} \quad m > \sqrt{21} > n$$

$$\text{Since} \quad 5 > \sqrt{21} > 4$$

therefore we must have

$$m \geq 5, n \leq 4$$

If on the contrary $m < n$, we must have

$$n^2 > 21 > m^2$$

$$\text{Hence} \quad n \geq 5, m \leq 4$$

Then substituting in the expression for x one after another the values $n = 4, 3, 2, 1$, we can determine by trial the value of m which will make the value of x in each case integral. Thus we shall easily arrive at the solutions given by Baudhāyana.

A much more difficult problem of the same type arises in connexion with the construction of the falcon-shaped Fire-altar. Its total area is given to be $7\frac{1}{2} a^2$, where a = a purusa. It is laid down that the altar must be constructed in fire layers and the number of bricks employed in any layer must be 200. As before, the rifts of bricks in any two successive layers must not coincide. There is no injunction of the scriptures about the varieties of the bricks to be employed or about their relative size and shape. In one method of construction Baudhāyana employs four kinds of square bricks whose sides are respectively the fourth, fifth, sixth and tenth part of a . Let us take, in general, the areas of bricks to be $a^2/m, a^2/n, a^2/p, a^2/q$. If x, y, z, u be the number of bricks of each variety respectively that are employed in a layer, the problem amounts

algebraically to the solution of the indeterminate equations

$$\left. \begin{aligned} \frac{x}{m} + \frac{y}{n} + \frac{z}{p} + \frac{u}{q} &= 1 \\ x + y + z + u &= 200 \end{aligned} \right\} \quad (B)$$

Baudhāyana gives two integral solutions of these equations¹

$$(i) \quad m=16 \quad n=20 \quad p=36 \quad q=100$$

$$(ii) \quad x=24 \quad y=120 \quad z=36 \quad u=20$$

$$(i') \quad x=12 \quad y=120 \quad z=63 \quad u=0$$

Since in this method the values of m , n , p , q are perfect squares the shape of all the bricks are square. Baudhāyana has described a second method of construction of the *Agni* in which he employs certain rectangular bricks too. These bricks it may be noted are easily divisible into square shapes. But as that will increase the number of bricks employed in the construction of the *Agni* he has refrained from doing so. All those things are however immaterial for us who look upon his problem from the point of view of the solution of algebraic equations. Baudhāyana's new solutions of the equations (B) are²

$$(ii) \quad m=25 \quad n=50 \quad p=50/3 \quad q=100$$

$$(ii-1) \quad x=160 \quad y=30 \quad z=8 \quad u=2$$

$$(ii-2) \quad x=165 \quad y=25 \quad z=6 \quad u=4$$

Āpastamba uses square bricks of five different varieties for the construction of the same *Agni*. So his problem will be represented algebraically by the equations

$$\left. \begin{aligned} \frac{x}{m} + \frac{y}{n} + \frac{z}{p} + \frac{u}{q} + \frac{v}{r} &= 7\frac{1}{2} \\ x + y + z + u + v &= 200 \end{aligned} \right\} \quad (C)$$

¹ BSI 1 ff

² BSI 41 ff

where m, n, p, q, r are perfect squares Āpastamba's statement of his method of solution, partly explained in detail and partly hinted, is not free from ambiguity¹ Consequently it has been interpreted differently by his different commentators leading consequently to several solutions According to Karavindasvāmī, the two solutions of (C) will be

$$(i) \begin{cases} m=16, & n=25, & p=64, & q=100, & r=144, \\ x=67, & y=58, & z=48, & u=18, & v=9, \end{cases}$$

$$(ii) \begin{cases} m=16, & n=25, & p=36, & q=64, & r=100, \\ x=12, & y=157, & z=9, & u=0, & v=22 \end{cases}$$

To these Karavindasvāmī adds the solution

$$(iii) \begin{cases} m=16, & n=25, & p=36, & q=64, & r=100, \\ x=10, & y=159, & z=9, & u=8, & v=14 \end{cases}$$

Sundararāja's interpretation leads to as many as four new solutions of (C)

$$(iv), (v) \begin{cases} m=16, & n=25, & p=36, & q=64, & r=100, \\ x=70, & 12, & y=45, & 157, & z=9, & u=56, & 0, & v=20, & 22, \end{cases}$$

$$(vi), (vii) \begin{cases} m=16, & n=25, & p=64, & q=100, & r=144, \\ x=74, & 77, & y=45, & 42, & z=52, & 40, & u=20, & 32, & v=9 \end{cases}$$

He has also added a few more solutions of his own All these show very clearly that the Hindus fully recognised the indeterminate character of the above problem of the construction of the Fire-altar of the shape of the falcon

¹ *ĀpŚl*, vi 1 ff The text describing one solution is positively faulty as has also been noticed by all the commentators Bürk failed to detect this He thinks erroneously that the preliminary arrangement for the second construction is comprised of 194 bricks, whereas it actually consists of 198 bricks (vide *ZDMG*, LVI p 366)

Several other indeterminate problems of the above type present themselves in connexion with the construction of the Fire altars of other shapes. We need not dilate upon them here. It should however be noted that the actual difficulties of construction are much more than what will appear from the mere algebraic considerations. For the bricks will have to be arranged in such a configuration as to have the prescribed shape of the altar

CHAPTER XV

ELEMENTARY TREATMENT OF SURDS

In the *Sulba*, we find elementary treatment of surds, particularly their addition, multiplication and rationalization. For the face, base and altitude of the *Sautiā manikī-vedi* which is of the shape of an isosceles trapezium, are stated, it has been noted before,¹ to be respectively $24/\sqrt{3}$, $30/\sqrt{3}$ and $36/\sqrt{3}$ prakramas, or to be $8\sqrt{3}$, $10\sqrt{3}$ and $12\sqrt{3}$ prakramas. Hence it is clear that the ancient Hindus knew that

$$\frac{24}{\sqrt{3}} = 8\sqrt{3}, \quad \frac{30}{\sqrt{3}} = 10\sqrt{3}, \quad \frac{36}{\sqrt{3}} = 12\sqrt{3}$$

It is also stated in general that if the side of a square be a , then the side of the square equal to the third part of it will be $\frac{1}{3}(a\sqrt{3})$ or $\sqrt{3}(\frac{a}{3})$.² That is,

$$\frac{a}{\sqrt{3}} = \frac{a\sqrt{3}}{3}$$

Thus it appears that the rationalization of simple surds was known at that time.

The area of the above trapezium is stated to be 324 square prakramas. It must have been calculated with the help of the rule given in the *Sulba* for that purpose. So that

$$\frac{36}{\sqrt{3}} \times \frac{1}{2} \left(\frac{24}{\sqrt{3}} + \frac{30}{\sqrt{3}} \right) = \frac{36}{3} \times \frac{54}{2} = 324$$

$$12\sqrt{3} \times \frac{1}{2} (8\sqrt{3} + 10\sqrt{3}) = 12 \times 3 \times 9 = 324$$

¹ *Supra*, p 153

² *ĀpŚl*, II 3, *BŚl*, I 47, *KŚl*, II 15 6, see also pp 74 f *supra*

Again the dimensions of another isosceles trapezium (*Isamedhuliv di*) are stated thus face = $21\frac{1}{2}$ base = $33\frac{1}{2}$ altitude = $36\sqrt{2}$ prakramas and area = 1914 square prakramas That is

$$36\sqrt{2} \times \frac{1}{2}(24\frac{1}{2} + 30\sqrt{2}) = 1914$$

In the *Sulba* a surd is technically called *harani*. Thus *du harani* means $\sqrt{2}$ *tri harani* = $\sqrt{3}$ *trija harani* = $\sqrt{1/3}$ *saptama harani* = $\sqrt{1/7}$ *ashtadasa harani* = $\sqrt{18}$ etc.¹ The term was also used in the more general sense of a root. For we have at least one instance of its application in that sense e.g. *caturharani* = 4 which is not a surd. The Sanskrit word *harani* means producer

that which makes. From that it came to denote the sides of a rectilinear geometrical figure of any shape² and then more particularly the side of a square

Approximate Value of $\sqrt{2}$

Baudhayana and Āpastambī say

Increase the measure (of which the *du harani* is to be found) by its third part and again by the fourth part (of this third part) less by the thirty fourth part of itself (i.e. of the fourth part) (The value thus obtained is called) the *savisēga*.³

Katvayana defines the rule in nearly identical words.⁴ Thus if *d* be the *du harani* of *a* that is if *d* be the side

¹ The 1 a pe t ly t *ApSl* 5 3 5
1

² *ApSl* 6

³ See *ApSl* 6 u 5 6 9 x 1 et

⁴ प्रमाणं हतायनं वदयेत्तस्य चतुर्थनाम्नचतुर्विंशतिना सविशेषः । —*BSI* 1 61
ApSl 6

⁵ * करणीं हतयेत्त वदयेत्तस्य चतुर्थनाम्नचतुर्विंशतिना सविशेष इति विशय
—*ASI* 13

of a square whose area is double that of the square on a , then, according to the rule,

$$d = a + \frac{a}{3} - \frac{a}{3 \cdot 1} - \frac{a}{3 \cdot 4 \cdot 31}$$

Now, it has been stated before the diagonal of a square is its *du-karani*. So this rule gives the relation between the diagonal and side of a square. Indeed the above rule is particularly meant to define that relation. Thus we get

$$\sqrt{2} = 1 + \frac{1}{3} - \frac{1}{3 \cdot 1} - \frac{1}{3 \cdot 4 \cdot 31}$$

In terms of decimal fractions, this works out $\sqrt{2} = 1.1142156$. According to modern calculation $\sqrt{2} = 1.114213$. Thus it is clear that the ancient Hindus attained, a very remarkable degree of accuracy in calculating an approximate value of $\sqrt{2}$.

Hypotheses about its Origin

One will be naturally interested to know how the value of $\sqrt{2}$ was determined in that early time to such a high degree of approximation. Unfortunately the Hindus have not left any trace of the method adopted by them for the purpose. So it is very difficult to guess it. Thibaut has, however, propounded an ingenious hypothesis about it. He says ¹

“The question arises how did Baudhāyana or Āpastamba or whoever may have the merit of the first investigation, find this value? Certainly they were not able to extract the square root of 2 to six places of decimals, if they have been able to do so, they would have arrived at still greater degree of accuracy. I suppose that they arrived at their result by the following method which account for the exact degree of accuracy they reached

¹ *Sulbasūtras*, pp. 13 ff

Undervouring to discover a square the side and diagonal of which might be expressed in integral numbers they began by assuming two as the measure of a square & side Squaring two and doubling the result they got the square of the diagonal in this case = eight They then tried to arrange eight let us say again eight pebbles in a square as we should say they tried to extract the square root of eight Being unsuccessful in this attempt they tried the next number taking three for the side of a square but eight yielded a square root no more than eight had done They proceeded in consequence to four five etc Undoubtedly they arrived soon at the conclusion that they would never find exactly what they wanted and had to be contented with an approximation The object was now to single out a case in which the number expressing the square of the diagonal approached as closely as possible to a real square number I subjoin a list in which the numbers in the first column express the side of the squares which they subsequently tried those in the second column the square of the diagonal those in the third the nearest square number

1	2	1	11	242	256
2	8	9	12	288	289
3	18	16	13	338	324
4	32	36	14	392	400
5	50	49	15	450	441
6	72	64	16	512	529
7	98	100	17	578	576
8	128	121	18	648	625
9	162	169	19	722	729
10	200	196	20	800	784

“How far the Sūtrakāṇas went in their experiments we are of course unable to say, the list up to twenty suffices for our purposes. Three cases occur in which the number expressing the square of the diagonal of a square differs only by one from a square number, 8—9, 50—49, 288—289, the last case being most favourable, as it involves the largest numbers. The diagonal of a square the side of which was equal to twelve, was very little shorter than seventeen ($\sqrt{289} = 17$). Would it then not be possible to reduce 17 in such a way as to render the square of the reduced number equal or almost equal to 288?

“Suppose they drew a square the side of which was 17 padas long, and divided it into $17 \times 17 = 289$ small squares. If the side of the square could now be shortened by so much, that its area would contain not 289 but only 288 such small squares, then the measure of the side would be exact measure of the diagonal of the square, the side of which is equal to 12 ($12^2 + 12^2 = 288$). When the side of the square is shortened a little, the consequence is that two sides of the square a stripe is cut off, therefore a piece of that length had to be cut off from the side that the area of the two stripes would be equal to one of the 289 small squares. Now, as square is composed of 17×17 squares, one of the two stripes cuts off a part of 17 small squares and the other likewise of 17, both together of 34 and since these 34 cut off pieces are to be equal to one of the squares, the length of the piece to be cut off the side is fixed thereby, it must be the thirty-fourth part of the side of one of the 289 small squares.

“The thirty-fourth part of thirty-four small squares being cut off, one whole small square would be cut off and the area of the large square reduced exactly to 288 small squares, if it were not for one unavoidable circumstance

The two stripes which are cut off from two sides of the square let us say the east side and the south side intersect or overlap each other in the south east corner and the consequence is that from the small square in that corner not $\frac{1}{34}$ are cut off but only $\frac{2}{34} - \frac{1}{34 \times 34}$. Thence the

error in the determination of the value of the savisesa. When the side of a square was reduced from 17 to $16\frac{1}{2}$ the area of the square of that reduced side was not 288

but $288 + \frac{1}{34 \times 34}$. Or putting it in a different way taking

17 for the side of a square dividing each of the 12 part into 34 parts (altogether 408) and dividing the square into the corresponding small squares we get $408 \times 408 = 166464$. This doubled = 332928. Then taking the avisehi value of $16\frac{3}{4}$ for the diagonal and dividing the square of the diagonal into the small squares just described we get $577 \times 577 = 332929$ such small square. The difference is high enough.

The relation of $16\frac{3}{4}$ to 12 was finally generalised into the rule increase a measure by its third then third by its own fourth less the thirty fourth part of the fourth.

$$\left(16\frac{3}{4} = 12 + \frac{12}{3} + \frac{12}{3 \times 4} - \frac{12}{3 \times 4 \times 34} \right) \quad \text{The example of}$$

the savisesa given by commentators; indeed $16\frac{3}{4}$ to 12 the case recommended itself by being the first in which the third part of a number and the fourth part of the third part were both whole number.

But a more simple and very plausible hypothesis will be that the expression for $\sqrt{2}$ was obtained in the following way.¹ Take two squares whose sides are of unit

¹ For slightly different but less important procedure see Müller p. 187.

length Divide the second square into three equal strips

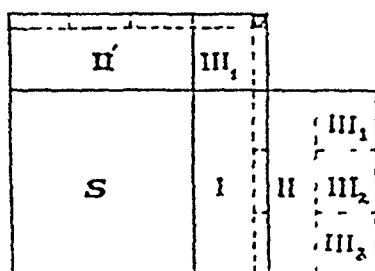


Fig. 75

I, II and III Sub divide the last strip into three small squares III_1, III_2, III_3 of sides $\frac{1}{3}$ each. Then on placing II and III_1 about the first square S in the positions II' and III'_1 , a new square will be formed. Now divide each of the portions III_2 and III_3 into four equal strips. Placing four and four of them about the square just formed, on its east and south sides, say, and introducing a small square at the south-east corner, a larger square will be formed, each side of which will be obviously equal to

$$1 + \frac{1}{3} + \frac{1}{3 \cdot 4}$$

Now this square is clearly larger than the two original squares by an amount $\left(\frac{1}{3 \cdot 4}\right)^2$, the area of the small square introduced at the corner. So to get equivalence cut off from the either sides of the former square two thin strips. If x be the breadth of each thin strip, we must have

$$2x\left(1 + \frac{1}{3} + \frac{1}{3 \cdot 4}\right) - x^2 = \left(\frac{1}{3 \cdot 4}\right)^2$$

Whence, neglecting x^2 as too small, we get

$$x = \left(\frac{1}{3 \cdot 4}\right)^2 \frac{3 \cdot 4}{34} = \frac{1}{3 \cdot 4 \cdot 34}$$

Thus we have finally

$$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3 \cdot 1} - \frac{1}{3 \cdot 4 \cdot 34}$$

nearly

Approximate Value of $\sqrt{3}$

By the process indicated above we can easily get an approximate value of $\sqrt{3}$. In this case two of the unit squares are divided into six equal strips I II VI. The last two strips are subdivided into six smaller squares of sides $1/3$ each. Then arranging the slices III IV V_1 V_2 VI_1 and VI_2 about the first square in the positions III' IV' V'_1 V'_2 VI'_1 VI' a new square can be formed. Now divide each of the portions left over viz. V_3 and VI into

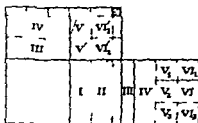


FIG. 76

five equal parts and place them about the square just formed. Then introducing a small square at the corner another complete square of sides equal to

$$1 + \frac{2}{3} + \frac{1}{3 \cdot 5}$$

each will be formed. But this is clearly too large by the amount $(\frac{1}{3})$. So for closer approximation let the side of the new square be diminished by an amount y such that

$$2y \left(1 + \frac{2}{3} + \frac{1}{3 \cdot 5} \right) - y^2 = \left(\frac{1}{3 \cdot 5} \right)$$

Hence $y = \frac{1}{3 \ 5 \ 52}$, nearly

Thus we get ¹

$$\sqrt{3} = 1 + \frac{2}{3} + \frac{1}{3 \ 5} - \frac{1}{3 \ 5 \ 52}$$

Irrationality of $\sqrt{2}$

Did the ancient Hindus recognise the irrationality of $\sqrt{2}$? This question does not seem to have troubled Thibaut in any way. For we do not find him to raise it explicitly or to attempt to answer it directly. But it is clear from his writings that he believed in the Hindu knowledge of irrationality of $\sqrt{2}$. Indeed his theory about the discovery of the Hindu approximation to the value of $\sqrt{2}$, which has been quoted *in extenso* before, is fundamentally based on the knowledge of the incommensurability of the diagonal of a square with its sides. Thibaut supposes that the ancient Hindus endeavoured 'to discover a square the side and diagonal of which might be expressed in integral numbers' and then observes, 'undoubtedly they arrived soon at the conclusion that they would never find exactly what they wanted and had to be contented with an approximation.' Von Schroeder ² and Burk ³ are more explicitly emphatic. They claim for the ancient Hindus the credit for the first discovery of irrationals. And they have been followed in this respect by Garbe, Hopkins and Macdonell ⁴. But this hypothesis has

¹ For a different method of approximating to the value of $\sqrt{3}$, see Muller, *loc cit*, pp 182 f

² Von Schroeder, *Pythagoras und die Inder*, Leipzig, 1884, pp 39-59, compare also *Indien Literatur und Kultur*, Leipzig, 1887

³ ZDMG, LV, p 557

⁴ R Garbe, *Philosophy of Ancient India*, pp 39 ff, E W Hopkins, *Religion of India*, pp 559 f, A A Macdonell, *History of Sanskrit Literature*, p 422

been criticised and opposed by some modern historians of mathematics¹

There are two terms which have undoubtedly a great bearing on the point under discussion. They are *viśeṣa* and *śaṭśeṣa*. Importance of these terms has not been properly realised by previous writers. Thibaut simply observes that *śaṭśeṣa* is a technical name for the increased measure. Burk remarks: "The total increase is *viśeṣa* because it is the difference between the *pramāṇa* i.e. the side of the given square and its *dvilāraṇi*. Therefore this latter is *śaṭśeṣa* with the difference"²

In the *Sulba* the calculated value of the diagonal of a square is technically called the *śaṭśeṣa* of its side. Or symbolically³

$$\text{Śaṭśeṣa of } a = a + \frac{a}{8} + \frac{a}{32} - \frac{a}{32768}$$

Now what is the radical significance of the term *śaṭśeṣa*? Before answering this question we shall point out that occasionally the term has been used to denote the complete diagonal in general that is in the sense *śaṭśeṣa* of $a = a\sqrt{2}$. Again in one instance in the *Āpastamba*

¹ H. G. Zuthen: "The remainder of Pythagoras' Original Geometrical Propositions", *Complex Rend. d. l'Im. Congr. d. Int. d. Phil. Sci.* G. 1904, M. C. to Ube d. Alte t. nd s. b. M. th. mat. k. A. cl. d. Mat. Phy. VIII (3) 1905 pp. 63-7. H. V. t. H. ben. d. l. n. Ind. r. d. Pyth. go. e. chen. L. hrs. t. und. d. I. t. n. l. gek. nnt. ? B. l. M. th. VII (3) 1906 pp. 6-3. T. L. H. th. Ev. l. d. I. p. 36 f.

² Thibaut: *S. l. b. t. s. p. 13*

³ Burk: *ZDMG* LVI p. 330 comp. 1. LV p. 545 (*s. s. s. s.* f. the p. p. r. o. m. t. n. t. the d. ka.) nd p. 557 f. 1. *BSI* 61.2 *ĀpŚi* 6 *KSī* 1. 13

⁴ *BSI* m. 67 149 150 *ĀpŚi* x. 2 3 4 7

Sulba,¹ we find the use

$$Viśesa \text{ of } a = \frac{a}{3} + \frac{a}{3 \ 4} - \frac{a}{3 \ 4 \ 34}$$

But on several occasions in this work and also in other *Sulbas*,² particularly in a compound word, the term *viśesa* has been employed in the sense of the hypotenuse of a right-angled triangle. And it has again been considered there as equivalent to *saviśesa*.³ The concluding portion of Kātyāyana's statement of the rule for *saviśesa* runs thus

1 “पृष्ठान्तयोर्मध्ये च शङ्कुनिहत्य अर्द्धं तद्विशेषमभ्यस्य लक्षणं कृत्वा अर्द्धभागमथेत
अन्त्यौ पाशौ कृत्वा, मध्यमे सविशेषं प्रतिमुच्य ” — *ĀpŚl* 11 1

² *BSl*, III 164, *ĀpŚl*, xx 5, 7, 8, 11, etc. In these cases occur the term *bāhya viśesa* (meaning “having the *viśesa* outwards”), in *ĀpŚl*, xx 6 we find *abhyantara-viśesa* (“having the *viśesa* inwards”).

³ For example, one kind of bricks employed in the construction of the Fire-altar of the shape of falcon with bent wings and spreadout tail (*Vakrapakṣa vyastapuccha syenacit*) was called *sodasī*. Its dimensions are described thus

“षोडशी चतुर्भिः परिगृह्णीयात् अष्टमेन, विभिरष्टैश्चतुर्थेन चतुर्थसविशेषेणेति” — *ĀpŚl*, xix 2

“Construct the *sodasī* with four (sides), namely with one eighth, three-eighth, one fourth (*purusa*) and the *saviśesa* of the one-fourth (*purusa*)” The manner of laying out these bricks has been described thus

“अवशिष्टं षोडशीभिः परिच्छादयेत् अन्या वाह्यावशिषा अन्तरशिरसः” — *ĀpŚl*, xv 5

“Cover the remaining portion (of the Fire altar) with *sodasīs*, (such that) those lying at the extremity (of the Fire altar) will have their *viśesa* outwards, but inwards at the head”

“अपरस्मिन् प्रस्तारे पुरस्ताच्छिरसि द्वे षोडशी वाह्याविशेषे उपदध्यात् ते अपरेण द्वे विषये अभ्यन्तरविशेषे” — *ĀpŚl*, xx 6

“In the second layer, at the head towards the east lay two *sodasīs* having their *viśesa* outwards and on the west lay them with their *viśesa* inwards and lying in both places (*viśaya*, i.e., partly in the head and partly in body of the Fire altar)”

saviśesa iti viśeṣaḥ Here the word *viśeṣa* must be explained differently. The use of the same terms thus in varied significations has made the interpretation of their origin really difficult. Thibaut's explanation is obviously erroneous. Burdett is not full.

Let us now see how the origin and significance of the term *saviśesa* has been interpreted by the early commentators. Divakaranatha Jayva is of no help to us in this matter. He passes off with the simple remark that *saviśesa* is a technical term for it. Harpardisvami observes

Saviśesa is a technical name for the sum thus obtained¹. As it is accompanied with a special quantity in excess (*viśeṣa*) so it is a term whose meaning is intelligible by itself. (Add) to twelve (angulis) four (angulis) to four one divide that one into thirty four parts and leave out a part. Thus (the resulting sum) will be seventeen angulis less one *tila*. The square of the *tilas* in twelve angulis is 166464 square *tilas* the square of the *tilas* in seventeen angulis minus one *tila* is 332929 square *tilas*. In this (latter) a square of one *tila* is in excess (of twice the other) so the *saviśesa* is the technical name (for it). If it is accompanied with some quantity in excess (*viśeṣa*) then what is the necessity for it? In its own domain it has no fault. For if the diagonal be measured (directly) with a bamboo stick the excess will be to the extent of ten square *tilas*. Thus in any case there will be an excess even by a fraction of the smallest part of the minute *nivara* grain falling from the mouth of a parrot. So (the formula) is without fault. It will be of practical use taking this into consideration the learned author has made that (technical) term

¹
$$T = \frac{1}{2} + \frac{1}{3} + \frac{1}{34} = \frac{6}{3434}$$

Karavindasvāmī's observations are more elaborate

"*Saviśca* is its technical name. The measure of the side (of a square) after having been operated upon by the rule 'increase the measure by its one third, etc.' is called the *saviśca*. For instance, increase a measure of twelve angulis by four angulis, increase that four angulis by one anguli minus one tila. The experts (in measure) say that thirty-four tilas placed breadthways make one anguli. It will be stated (later on in the text) 'add to half (the length of the east-west line) its *viśca*,'¹ 'enclose with two half-bricks having their *viśca* outwards,'² etc. What (are the correct meanings) of 'fasten *saviśca* to the middle (pole),'³ 'with one-fourth purusa and with the *saviśca* of one-fourth purusa,'⁴ etc. There it should be understood that 'being with the *viśca*,' that is 'the measure with the *viśca*' is the *saviśca*. What is the need of this big term? So that its true significance may be intelligible by itself. What is that? The root *śis* when prefixed by *vi* denotes in all cases 'a correction in excess'. As the rule mentions of an excess qualified by the prefix *vi* (it should be understood that the accurate value of) the diagonal differs by something from, exceeds over the exceeding part of the above value of the *dvi-karani* over the measure of the side and that is the *viśca*. Or else the *viśca* is that little area by which (the square of the diagonal as calculated by the rule) differs from or exceeds over (twice the area of the given square) at the time of measurement. For instance, since it has been stated that thirty-four tilas make one anguli, the square of the number of tilas in twelve angulis is 166464 square areas of tilas, the square of the tilas in seventeen angulis minus one tila is 332929 square areas of tilas. In the latter a square of one tila is present in excess over twice the area of the (given)

¹ *ĀpŚI*, II 1

³ *Ibid*, II 1

² *Ibid*, XX 7

⁴ *Ibid*, XIX 2

square figure hence its technical name is *vishra*. If the diagonal (of the square) could be (exactly) measured with the bamboo rod and the Fire altar had been measured by means of that measure the area included in the body (of the Fire altar) would not have exceeded (twice) this (the given square) even by the smallest part of the minute *niara* grain falling from the mouth of a parrot. If the measure falls short (the area described) in that case will also be smaller. So for doubling (a square) the *satisesa* is employed as a practical means.

Thus it is evident that according to the interpretation of the commentators Kapardisvami and Karavindasvami the term *satisesa* for the diagonal of a square implies intrinsically a knowledge of the following: (1) The value of the diagonal as calculated by the rule stated for the purpose is only an approximate one. (2) that value of the diagonal has a small quantity in excess over the true value of the diagonal or in other words the square of that value exceeds by some quantity twice the area of the given square. (3) that excess cannot be completely eliminated in calculating the value of the diagonal arithmetically. If the validity of this interpretation be accepted then there will remain nothing to doubt that the ancient Hindus were aware of the incommensurability of the diagonal of a square with its sides.

Let us therefore test as far as possible how far the commentators can be relied upon in the matter of that interpretation. For it might be argued by modern critics that being acquainted with the real state of things from the mathematical knowledge of their time the commentators naturally gave an interpretation to the texts which was more creditable to their authors.¹ Looking into the

¹ The commentators have been similarly cited in other connections by Theodor Shtetgen (pp. 46 f.) and Bick (in *Ant. Ap. 1* 4).

ancient literatures of India, we find in the early canonical works of the Jainas copious instances of the employment of the term *viśesa* in the same connection as we find it in the *Sulba*. Thus in the *Sūryaprajñapti* (c 500 B C)¹ the circumference of a circle whose diameter is 99640 *yojanas* is stated as 315089 *yojanas* and a little over (*kiñcidviśeṣādhika*), that of a circle of diameter 100660 *yojanas* is stated to be 318315 and a little less (*kiñcid-viśesona*). In the *Jambudvīpaprājñapti* (c 300 B C),² the circumference of the Jambudvīpa which is of the shape of a circle of 100000 *yojanas* in diameter, is mentioned as 316227 *yojanas* 3 *gavyutis* 128 *dhanus* 13½ *angulis* and a little over (*kiñcid-viśeṣādhika*). In all these cases,³ it will be seen that the value actually recorded is only an approximate one and the *viśesa* refers to a small quantity which has not been recorded—in fact it cannot be accurately determined—but which we shall have to add to or subtract from the recorded value in order to get the accurate value of the quantity sought. Those who are acquainted with the technique of Sanskrit and Sanskritic languages will at once recognise that the expression *kiñcid-viśeṣādhika* has the identical significance as the term *saviśesa*. Indeed we really find the use of the word *saviśesa* in exactly the same sense in a Jaina work of later times. Nemicaṇḍra (c 975 A D) writes *tattvūnam parivayena saviśesam* or “ thrice that with a little over (*saviśesa*) is the circumference ”⁴. Now the early canonical works of

¹ Sūtra 20 The formula employed for the calculation is

$$\text{circumference} = \sqrt{10 \times (\text{diameter})^2}$$

² Sūtra 3

³ Several instances of this kind will be found in the author's article on “ The Jaina School of Mathematics ” in the *Bull Cal Math Soc*, Vol XXI, 1929, pp 115 145, see particularly pp 131-3

⁴ *Trilokaśāra* of Nemicaṇḍra, with the commentary of Mādhava-candra, edited by Manoharlal Sastri, Bombay, 1918, Gāthā 95

the Jainas belong to a period not much separated from that of the *Sulba*. Some works of either classes probably belong to the same age. So we can accept without any hesitation that the term *sarīśasa* was employed originally in the *Sulba* with the same significance as that with which it is found to have been employed in the early canonical works of the Jainas. Thus it is found conclusively that Kapardīsvami and Karavindasvami are thoroughly reliable as regards their interpretation of the original significance of the term *sarīśasa*. So it is proved that the irrationality of $\sqrt{2}$ was known to the ancient Hindus.

Other Approximate Values of $\sqrt{2}$

From the *Manava Sulba* we obtain certain other noteworthy approximations to the value of $\sqrt{2}$. By way of some calculations in that work are employed the relations

$$(1) \quad 40 + 40^2 = 56^2$$

$$(2) \quad 4 + 4 = (5\frac{2}{3})^2$$

From these we easily derive the values

$$(1) \quad \sqrt{2} \approx \frac{56}{40} = 1.4$$

$$(2) \quad \sqrt{2} \approx \frac{16}{15} = 1.4166$$

It may be noted that $\frac{16}{15}$ is the third convergent of $\sqrt{2}$ expressed as a continued fraction¹ and the value $\frac{56}{40}$ is its fourth convergent. What is still more noteworthy is the fact that the former value is not derivable from the series for $\sqrt{2}$ stated before. This latter is however the eighth convergent of the continued fraction for $\sqrt{2}$

$$\frac{577}{408} = 1 + \frac{1}{3} + \frac{1}{3 \cdot 4} - \frac{1}{3 \cdot 4 \cdot 34}$$

$$1. \quad \sqrt{2} = 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{24} + \dots$$

These facts will lead one strongly to suspect if the rudiments of the theory of continued fractions were known to the early Hindus. At any rate, these are very remarkable cases of coincidence.

There are certain other rough values of $\sqrt{2}$ to which we shall refer shortly.

Approximation to the Value of $\sqrt{5}$

There seems to have been a serious attempt, though without much success, to find an approximation to the value of the surd $\sqrt{5}$. The occasion was to define clearly the relative positions of the three principal and oldest known fire-altars, viz., the *Gārhapatya*, *Āhavanīya* and *Dakṣiṇa*. Baudhāyana's rules to determine their positions are these:

“With the third part of the length (i.e., the distance between the *Gārhapatya* and *Āhavanīya*) describe three squares closely following one another (from the west towards the east), the place of the *Gārhapatya* is at the north-western corner of the western square, that of the *Dakṣiṇāgni* is at its south-eastern corner, and the place of the *Āhavanīya* is at the north-eastern corner of the eastern square.”¹

“Or else divide the distance between the *Gārhapatya* and *Āhavanīya* into five or six (equal) parts, add (to it) a sixth or seventh part, then divide (a cord as long as) the whole increased length into three parts and make a mark at the end of two parts from the eastern end (of the cord). Having fastened the two ends of the cord (to the two) poles at the extremities of the distance between the *Gārhapatya* and *Āhavanīya*, stretch it toward the south, having taken it by the mark and fix a pole at the point reached. This is the place of the *Dakṣiṇāgni*.”²

¹ BŚI, 1 67

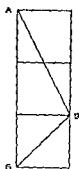
² BŚI, 1 68

Or else increase the measure (between the *Garhapatya* and *Iharaniya*) by its fifth part divide (a cord as long as) the whole into five parts and make a mark at the end of two parts from the western extremity (of the cord) Having fastened the two ties at the ends of the east west line stretch the cord towards the south having taken it by the mark and fix a pole at the point reached This is the place of the *Dakṣina jni* ¹

The second is also given by *Īpastamba* ² A rule leading to the same result as the first one above though defined differently is stated by *Kaṭyayana* ³ and *Manu* ⁴ *Kaṭyayana* has specified the relative positions of the three fire altars also in a new way

Divide the distance between the *Garhapatya* and *Āharaniya* into six or seven parts add a part then divide (a cord) equal to the total increased length into three parts etc ⁵

The rest of this rule is the same as the latter portion of the second rule above and hence need not be mentioned



Λ = *Iharaniya*
 G = *Garhapatya*
 D = *Dakṣina jni*

FIG 77

¹ *Ib d* 69

⁴ *M Śl* 1

² *ApŚl* 5 4

³ *KŚl* 9

⁵ *KŚl* 7

Let b denote the distance between the *Gārhapatya* and *Īharanyā*, that is, $1G$. Then from the different specifications given above we obtain the following values for AD and GD

$$1D = \frac{1}{2}\sqrt{5}, \frac{1}{3}b, \frac{2}{3}b, \frac{1}{21}b, \frac{1}{2}b$$

$$GD = \frac{1}{2}\sqrt{2}, \frac{2}{3}b, \frac{1}{15}b, \frac{1}{21}b, \frac{1}{2}b$$

If it be assumed that the relative positions of the three fire-altars were meant to be the one and the same, in all cases though expressed differently, then we shall have the following approximations to the values of $\sqrt{5}$ and $\sqrt{2}$

$$\sqrt{5} = 2\frac{2}{5}, 2\frac{1}{3}, 2\frac{2}{7}, 2\frac{4}{25},$$

$$= 2\frac{4}{10}, 2\frac{333}{1000}, 2\frac{285}{1000}, 2\frac{16}{1000}$$

$$\sqrt{2} = 1\frac{1}{2}, 1\frac{1}{6}, 1\frac{1}{4}, 1\frac{1}{25},$$

$$= 1\frac{2}{10}, 1\frac{166}{1000}, 1\frac{142}{1000}, 1\frac{44}{1000}$$

Since according to modern calculation $\sqrt{2} = 1.414213$ and $\sqrt{5} = 2.23607$, none of the above values can be said to be a fair approximation, perhaps except the values $\sqrt{5} = 2\frac{2}{7}$ and $\sqrt{2} = 1\frac{1}{2}$ which are correct up to the first place of decimals

Evaluation of Other Surds

In the *Mānava Śulba*, we find results leading incidentally to the evaluation of two other surds

$$36^2 + 90^2 = 97^2$$

$$5^2 + 61^2 = (75)^2$$

Whence we easily obtain

$$\sqrt{29} = 5\frac{7}{8} = 5.875$$

$$\sqrt{61} = 7\frac{5}{8} = 7.625$$

Now correct up to three places of decimals $\sqrt{29} = 5.385$
 and $\sqrt{61} = 7.810$ Hence the above approximations
 specially the first one may be said to be fair for
 ordinary purpose

Approximate Formula

It would be natural to ask if there is in the *Sulba* any specific rule for determining the approximate value of any surd. But the answer is not very reassuring. For we do not find an express statement of any formula for the purpose. At the same time we can unhesitatingly admit that they had the necessary equipments for the approximate evaluation of surds at least of some. We have pointed out before that in the science of the *Sulba* it is sometimes necessary to construct a square having a given area. And that is a geometrical method of finding the square root of a given number. If the given area is represented by a non square number we get a method finding the square root of a non square number. One formula follows at once from the method given in the *Sulba* for the transformation of a rectangle into a square which has been described before. According to this method a square (having its side equal to the breadth of the given rectangle) is first cut off from the given rectangle the excess portion is divided into two halves which are then joined to the two sides of that square. Then by adding a small square in the corner a large square is completed. The square equivalent to the given rectangle will be obtained it is said by subtracting the added small square from the completed large square. This subtraction was doubtless made by the *Sulba* workers with the help of the theorem of the square of the diagonal. But it can also be made by cutting off two strips from the two sides say the east side and the south

side of the completed large square ¹ Suppose A to be the area of the given rectangle and a be the side of the square subtracted from it Then the side of the large completed square will be $a + \frac{A-a^2}{2a}$ The area of the small added square will be $\left(\frac{A-a^2}{2a}\right)^2$ Then from each side of the large square we shall have to cut off a thin strip of the same breadth If x denote the breadth of the strip, we must have

$$\left(\frac{A-a^2}{2a}\right)^2 = 2x\left(a + \frac{A-a^2}{2a}\right) - x^2$$

$$\text{or} \quad x = \frac{\left(\frac{A-a^2}{2a}\right)^2}{2\left(a + \frac{A-a^2}{2a}\right)},$$

neglecting x^2 as being very small Hence we finally arrive at the formula

$$\sqrt{A} = a + \frac{A-a^2}{2a} - \frac{\left(\frac{A-a^2}{2a}\right)^2}{2\left(a + \frac{A-a^2}{2a}\right)}$$

This formula requires a correction, it will be easily recognised, inasmuch as a portion equivalent to x^2 has been subtracted too much

¹ The process is in fact the reverse of that taught in the *Sulba* for the increment of a given square into another square

The rule of the Bakhshali Manuscript for determining the approximate root of a non square number must have been obtained exactly in this way. It says¹

In case of a non square (number) subtract the nearest square number divide the remainder by twice (the root of that number). Half the square of that (that is the fraction just obtained) is divided by the sum of the root and the fraction and subtract (this will be the approximate value of the root) less the square (of the last term)

If $1 = a + r$ we write the above formula as

$$\sqrt{A} = \sqrt{a + r} = a + \frac{r}{2a} - \frac{(r/2a)^2}{2(a + r/2a)}$$

Now this formula will not be available for finding the approximate values of those surds in which r is not small compared with a^2 . So Rodet holds that a different process of approximation to the value of a surd was also known to the authors of the *Sulba*. It will lead to the formula says he

$$\sqrt{a + r} = a + \frac{r}{2a+1} + \frac{\frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} +$$

¹ B b h t b h n D t t T b B k h h ā l M t h m t c B u C a l
M t h S o V Y I 19 9 p p 1 60

² L R d t S e m é t h o d e d p p o m t o d e r e n e r e
n e d a l I n d e a n t é i u r m t a l q u i t e d A l d o B u
S M u d F V I I 1879 p p 98 10 S u r l m é t h o d e
d p p m t n h l n e u — I b d p p 169 167

where

$$\epsilon = \left[1 - \left\{ \frac{1}{2a+1} + \frac{\frac{1}{2a+1} \left(1 - \frac{1}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} \right\} \right. \\ \times \left\{ 2a + \frac{r}{2a+1} + \frac{\frac{1}{2a+1} \left(1 - \frac{1}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} \right\} \left. \right] \\ - 2 \left\{ a + \frac{1}{2a+1} + \frac{\frac{r}{2a+1} \left(1 - \frac{1}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} \right\}$$

A nearly equivalent formula will be obtained by proceeding in the following way. From the given rectangle A , cut off the square (S) of side a each. Let the area of the remaining portion of the rectangle be r . From this cut off two strips I and II of the same breadth $r/(2a+1)$ and arrange them as in Fig 78. Then the area of the strip of the rectangle still left over will be

$$= 1 - 2a \times \frac{r}{2a+1} = \frac{r}{2a+1}$$

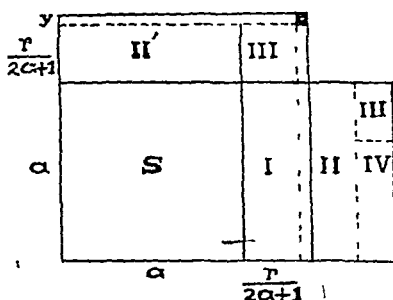


Fig 78

Complete the larger square by adding a portion III is deducted from $r/(2a+1)$. Then the area of IV will be

$$= \frac{r}{2a+1} - \left(\frac{r}{a+1} \right) = \frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)$$

Now this portion can be utilised in increasing the side of the square obtained before. If the increment of the side be y then we must have

$$2y \left(a + \frac{r}{2a+1} \right) + y^2 = \frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)$$

Therefore approximately

$$y = \frac{\frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)}$$

Hence the side of the equivalent square is nearly

$$a + \frac{r}{2a+1} + \frac{\frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)}$$

This is a little too great. So decrease the square by cutting off a strip of breadth from either side then

$$\begin{aligned} 2\epsilon \left\{ a + \frac{r}{2a+1} + \frac{\frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} \right\} - 2 \\ = \left\{ \frac{\frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} \right\}^2 \end{aligned}$$

whence, we get

$$c = \left\{ \frac{\frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} \right\}^2$$

$$- 2 \left\{ a + \frac{r}{2a+1} + \frac{\frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} \right\}$$

Thus we have finally

$$\sqrt{A} = \sqrt{a^2 + r} = a + \frac{r}{2a+1} + \frac{\frac{r}{2a+1} \left(1 - \frac{r}{2a+1} \right)}{2 \left(a + \frac{r}{2a+1} \right)} - c$$

nearly.

CHAPTER XVI

FRACTIONS AND OTHER MINOR MATTERS

Terminology

In the *Sulba* as in later Hindu mathematics the fraction is called *amśa bhaga* meaning part portion. Once in the *Ipastamba Sulba* and *Katyayana Sulba* each it is called *lala* ¹. This term is interesting inasmuch as it was used as early as the *Rigveda* to denote particularly a sixteenth part. It is also employed symbolically for the number sixteen. The unit fraction is indicated by a compound of either of those terms with a cardinal number e.g. *pañcadaśa bhaga* = $1/15$ (*IpSl* x 3 *KSl* v 4) *tri bhaga* = $1/3$ (*KSl*) or with an ordinal number e.g. *pañcama bhaga* = $1/5$ (*IpSl* ix 7 x 2 *KSl* v 6). Often times in the latter case the word *bhaga* is omitted so that we have only an ordinal to denote a fraction e.g. *pañcama* (or fifth) = $1/5$ *dvādaśa* (twelfth) = $1/12$ *trajādaśa* (thirteenth) = $1/13$ etc. ³

In the *Manava Sulba* ⁴ we find a few very strange and unusual instances where *dvi guna*, *tri guna* and *catur guna* are employed to denote respectively $1/2$, $1/3$ and $1/4$. But there we also meet with such usual use as *dvi guna* = 2 times *pañca guna* = 5 times. The former are indeed highly ambiguous applications.

It is much noteworthy that the authors of the *Sulba* did not restrict themselves to the use of unit fractions only as is known to have been the case with the early

¹ *ApSl* 10 *KSl* 11 Comp al *Uśa dogy* *Up n ś d v*
7 1 ² *Pl* ii 47 17

³ *BSl* 61 67 *IpSl* x 7 1 t It ho ld b ted th t
d das ś dāśa t l u d nth ca d l en

⁴ *MaSl* 5

⁵ *Ib d* : 5 6

Egyptian, Babylonian, and Chinese mathematicians ¹ In the *Sulba*, the unit fraction has not, indeed, any special significance attached to it We find in them the frequent use of the general fraction Their mode of expressing it is exactly the same as that of later Hindu writers Thus $\frac{3}{8}$ is called *tri-astama* ("three eighths"), $\frac{2}{7}$ *dvi-saptama* ("two-sevenths") ² Kātyāyana mentions $14\frac{3}{7}$ prakramas as *caturdaśa prakramān trīmsca prakrama-saptabhāgān* (or "14 prakramas and three of the seventh parts of a prakrama") ³ $\frac{3}{4}$ is sometimes called *catur-bhāgona* ("less one-fourth"), ⁴ that is, $1 - \frac{1}{4}$

A peculiar mode of expressing certain fractions is sometimes found in the *Sulba*, e g, *ardha-navama*, which literally means "containing a half for its ninth," is used to denote "eight and a half", *ardha-daśama* ("containing a half for its tenth") = $9\frac{1}{2}$, and so on ⁵ Such a term evidently carries with it the concrete concept of the operation of measuring

A fraction of a fraction is indicated in the usual way thus *jānoh pañcamasya caturvimśena* = "by $\frac{1}{24}$ of $\frac{1}{5}$ of a *jānu*" ⁶ Further *caturtha-saviśesārdha* = $\frac{1}{2} (\frac{1}{4} \sqrt{2})$, *caturtha-saviśesa-saptama* = $\frac{1}{7} (\frac{1}{4} \sqrt{2})$ ⁷

Operations with Fractions

In the *Sulba*, there are instances showing fundamental arithmetical operations with elementary fractions For example, it is stated in the *Baudhāyana Sulba* ⁸

¹ D E Smith, *History of Mathematics*, in two volumes, Boston, 1925, Vol II, pp 208 ff

² *ĀpŚl*, xix 2, 6

³ *KŚl*, vi 2

⁴ *ĀpŚl*, xv 5, xix 1

⁵ *BŚl*, ii 13, *ĀpŚl* iii 8, *MāŚl*, ii 1-2

⁶ *BŚl*, ii 13

⁷ *ĀpŚl*, xix 4, 7

⁸ *BŚl*, iii 106 Compare also *BŚl*, iii 238 9 and *ĀpŚl*, xviii 3 which give

$$7 \frac{1}{2} - \frac{1}{16} = 120$$

One hundred eighty seven and a half square bricks of sides (equal to) one fifth of a purusa make up the seven fold *Agni* with the two aratnis and the pradesa

Here the area of each brick is $1/25$ of a square purusa so the number of such bricks required to cover an area of $7\frac{1}{2}$ square purusas will be

$$7\frac{1}{2} \div \frac{1}{25} = \frac{15}{2} \times 25 = 187\frac{1}{2}$$

Thus it is an instance of division of fractions. Or the same result may have been obtained in a slightly different way which is indeed a simplified method of division. Since the area of each brick is $1/25$ of a square purusa one square purusa will contain 25 such bricks. Therefore an area of $7\frac{1}{2}$ square purusa will contain

$$7\frac{1}{2} \times 25 = 187\frac{1}{2}$$

bricks. If the area of each brick be One fifteenth of half of a square purusa says Baudh yana ¹ the number of bricks used will be 225. That is

$$7\frac{1}{2} \div \frac{1}{15} \text{ of } \frac{1}{2} = \frac{1}{2} \div \frac{1}{30} = \frac{15}{2} \times 30 = 225$$

In describing the *Dronacit* Baudhayana writes ²

Its body is a square its side is three purusa less one third. On the western side of the body is the handle. Its length east to west is half a purusa plus ten angulis and its breadth north to south is one purusa less one third. Thus is made the sevenfold *Agni* with the two aratnis and the pradesa

That is,

$$7\frac{1}{2} \text{ square purusas} = \left\{ \left(3 - \frac{1}{3} \right) \text{ purusas} \right\}^2 \\ + \left(\frac{1}{2} \text{ purusa} + 10 \text{ angulas} \right) \times \left\{ \left(1 - \frac{1}{3} \right) \text{ purusa} \right\},$$

the right-hand side, in square purusas

$$= \left(2\frac{2}{3} \right)^2 + \left(\frac{1}{2} + \frac{1}{12} \right) \left(1 - \frac{1}{3} \right), \\ = 7\frac{1}{9} + \frac{7}{12} \times \frac{2}{3}, \\ = 7\frac{1}{2}$$

The spatial dimensions of the constituent parts of the Fire-altar of the shape of the falcon with bent wings and spread-out tails have been described by Āpastamba as follow

“ Of the whole area making the seven-fold *Agni* with the two aratnis and the prādesā, take off the prādesa (from the tail), and the fourth part of the body together with eight quarter bricks Of these latter, (use) three for the head, then divide the remainder between the two wings ” ¹

Now, as is well-known, the body of the primitive Fire-altar of the shape of the falcon measures 4 square purusas, each wing $1 \times 1\frac{1}{2}$ square purusas and the tail $1 \times 1\frac{1}{10}$ square purusas On taking out the prādesā (= 1/10 purusa) from the tail, there will remain 1 square purusa The body will be reduced by

$$4 \times \frac{1}{4} + 8 \times \frac{1}{16} \text{ square purusas},$$

there will then remain

$$1 - \left(4 \times \frac{1}{4} + 8 \times \frac{1}{16} \right) = 2 \frac{1}{2} \text{ square puru as}$$

Of the former with $8 \times \frac{1}{16}$ square purusas is formed the head and the remainder

$$\frac{1}{4} + \frac{8}{16} - \frac{8}{16} = 1 \frac{1}{16} \text{ square purusas}$$

together with $1 \times \frac{1}{10}$ square purusas from the tail is divided equally between the two wings. Each wing will therefore measure

$$1 \times 1 \frac{1}{5} + \frac{1}{2} \left(1 \frac{5}{16} + \frac{1}{10} \right) \text{ square purusas}$$

Hence the total area of the Fire altar will be in square purusas

$$1 + 2 \frac{1}{2} + \frac{8}{16} + 2 \left\{ 1 \frac{1}{5} + \frac{1}{2} \left(1 \frac{5}{16} + \frac{1}{10} \right) \right\} = 7 \frac{1}{2}$$

Of the squaring of a fraction we take the following example from the *Āpastamba Sulba* ¹

A cord $1 \frac{1}{2}$ puru as long produces (a square of) $2 \frac{1}{4}$

(square purusas) $2 \frac{1}{2}$ purusas produce $6 \frac{1}{4}$ (square purusas)

That is

$$\left(1 \frac{1}{2} \right)^2 = 2 \frac{1}{4} \quad \left(2 \frac{1}{2} \right)^2 = 6 \frac{1}{4}$$

Baudhāyana states, on the contrary, that the side of a square measuring $7\frac{1}{9}$ square puruṣas is $2\frac{2}{3}$ puruṣas in length ¹ That is

$$\sqrt{7\frac{1}{9}} = 2\frac{2}{3}$$

Progressive Series

In the manner of laying out bricks described in the *Sulba*, we find a few interesting instances of progressive series Āpastamba writes

“On (the occasion of) the first construction, (the altar-builder) should construct (the Fire-altar) knee deep with 1000 bricks, on the second, navel-deep with 2000 bricks, on the third, mouth deep with 3000 bricks (The number of bricks employed in constructing the Fire-altar becomes thus) greater and greater on each successive occasion He who constructs to attain the Heaven, (should thus construct with) great, high and unlimited (*mahāntam brhantam aparimitam*) (number of bricks), so it is known (from the ancient scriptures) ” ²

Thus we have the A P

1000, 2000, 3000,

Reference to this progressive mode of successive construction of the Fire-altar is found as early as the *Taittirīya Samhitā* (c 3000 B C) ³ It reappears in the *Satapatha Brāhmaṇa* and Āpastamba expressly admits to have borrowed it from that work ⁴ We find there another noteworthy instance which shows that it was very likely known then how to sum up a series in A P

¹ *BSI*, III 220

² *ĀpSI*, x 8, see also *ĀpSr*, xvi 13 11-2, *BSI*, II 26

³ *TS*, v 6 8 23

⁴ *ĀpSM* xvi 13 12

But indeed that Fire altar also is the Metres for there are seven of these metres increasing by four syllables and the triplets of these make seven hundred and twenty syllables and thirty six in addition thereto ¹

It has been stated elsewhere in the same work that the shortest metre is the *Gayatri* with 24 syllables. Thus we are given the first term (24) the common difference (4) and the number of term (7) of a series in A P. Then its

$$\begin{aligned}\text{Sum} &= \frac{7}{2} \{2 \times 24 + (7-1)4\} \\ &= 252\end{aligned}$$

So the triplets of these metres will consist of 756 (= 252 × 3) syllables which are equal to 720 + 36 as stated

From the method indicated by Baudh yana for constructing larger and larger squares starting with a smaller one by adding successively gnomons to it is clear that the following series was known to him ³

$$1 + 3 + 5 + 7 + \dots + (2n+1) = (n+1)^2$$

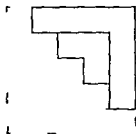


Fig 79

Factorisation

The true significance of another passage is not quite clear to us unless it is some mystic expression of an

¹ SB x 5 4 7 E g l g t n l t n ² V d s p a pp 15 ff

³ Comp r M II l t pp 00 f

attempt to find all the possible factors of a number
The *Satapatha Brāhmaṇa* says

“Now in this Prajāpati, the year, there are 720 days and nights, his lights, (being) those bricks, 360 enclosing stones, and 360 bricks with (special) formulas This Prajāpati, the year, has created all existing things, both what breathes and the breathless, both gods and men Having created all existing things, he felt like one emptied out, and was afraid of death He bethought himself, ‘How can I get these beings back into my body? how can I put them back into my body? how can I be again the body of all these beings?’ He divided his body into two, there were 360 bricks in the one, and as many in the other he did not succeed He made himself three bodies,—in each of them there were 3×80 of bricks he did not succeed He made himself four bodies of 180 bricks each he did not succeed He made himself five bodies,—in each of them there were 144 bricks he did not succeed He made himself six bodies of 120 bricks each he did not succeed He did not develop himself sevenfold ¹ He made himself 8 bodies of 90 bricks each he did not succeed He made himself 9 bodies of 80 bricks each he did not succeed He made himself 10 bodies of 72 bricks each he did not succeed He did not develop elevenfold He made himself 12 bodies of 60 bricks each he did not succeed He did not develop either thirteenfold or fourteenfold He made himself 15 bodies of 48 bricks each he did not succeed He made himself 16 bodies of 45 bricks each he did not succeed He did not develop seventeenfold He made himself 18 bodies of 40 bricks each he did not succeed He did not develop nineteenfold

¹ The text न सप्तधा व्यभक्त literally, means “did not become divided into seven (parts)”

He made himself 20 bodies of 30 bricks each he did not succeed He did not develop either twenty onefold or twenty twofold or twenty threefold He made himself 24 bodies of 30 bricks each There he stopped at the fifteenth and because he stopped at the fifteenth arrangement there are fifteen forms of the waxing and fifteen of the waning (moon) ¹

The significance of stopping after the fourteenth operation is obvious For after that there will be the repetition of the previous factors

¹ SB x 4 = 1 This translation substantially due to Σ_6 1
 " We have only indicated the ph for the numbers in words

APPENDIX

SOME TECHNICAL TERMS OF THE *SULBA*

Line of Symmetry of the Veda —Every one of the altars of various shapes that have been described in the *Sulba*, has a line of symmetry. Some which are square, rectangular or circular (with or without spokes) have, indeed, more than one such line. But primary importance is always attached even in those cases only to one of them. That line of symmetry of an altar is technically called the *prsthyā*. This term is derived from the word *pīstha* (or "back") and so means "the line marking the back or rather the back-bone of the altar." It has its origin in the comparison of the altar with an animal which occurs repeatedly in the *Samhitā* and *Bṛāhmaṇa*. For instance, the *Taittīyī Samhitā* observes, "The Fire-altar is an animal."¹

Configuration of the Veda —A sacrificial altar is built in such a configuration as to place its principal line of symmetry always along the west-to-east direction. Hence it is also called the *prācī*, or "the eastward line." This line, as has been already observed, is of primary importance in the geometry of the *Sulba*. For all constructions are described in the *Sulba* invariably with reference to it. The sides of an altar lying on either sides of its *prācī*, whether parallel to it or not, are called its *pāśvamānī*, from *pāśva* = "side" and *māna* = "measure," and hence meaning literally the "side measure," those which are at right angles to the *prācī* are called the *tiryakmānī* or the

transverse measure from *tiryāḥ* = transverse *mana* = measure. The latter term is oftentimes called in short *tiryāḥ* *tiraścina* or *tiraścī* (transverse) which are sometimes further abbreviated into *tirah*. These terms are very old and occur in the earliest literatures of the Hindus.¹ The transverse sides are again distinguished into *pascattiraścī* (the western transverse side) and *purastattiraścī* (the eastern transverse side). The former is also called the *mūḥa* (= the face) and the latter the *pada* (= the base) of the altar.

Line —The line is called in the *Sulba* *lekha* or *rekha* both the terms being identical as according to the rules of the Sanskrit Grammar the alphabets *l* and *r* can be replaced mutually. A straight line is distinguished as *ṛjulekha* *ṛju* meaning straight.²

Rectilinear Figures —In the *Sulba* we discern two different systems of nomenclature for the rectilinear geometrical figure.³ In one system the naming is according to the number of angles or corners in the figures and the names are formed by the juxtaposition of the number names with *asra* or *asra* which ordinarily means corner angle e.g. *tryasra* (triangle) *caturasra* (quadrangle) etc. These names were introduced in the time of the *Srauta* *sūtra* (2000-1500 B.C.). Still older names were compounds ending with *śraṭi* (= angle corner). Thus the name *caturśraṭi* which literally means the quadrangle occurs in the *Tajasaneyi Samhita*.

¹ F. 1 e e e TS 45 M S 84 < B v 1118

t

² BS/ 7 6 TS 45

³ BS/ 3

⁴ F. fall f m t th point th th t l O
th Had N m f th R t l e G m t al F th
J 1 f th A t S t J f B g t N 6 XXVI 1930 pp 83 90

Taittirīya Samhitā, *Satapatha Brāhmaṇa*, *Āpastamba Śrauta*, *Baudhāyana Śulba* and other works. In the *Rg-veda*, we find the term *navasrakṭi* referring to the "nine corners" of the heaven. In the *Kātyāyana Śulba Parīśista*,¹ we have compound names for rectilinear figures ending with *karna*. The Sanskrit word *karna* means the "ear." Applied to geometrical figures, it implies the "angle", hence *trikarna* = "triangle," *pañcakarna* = "pentagon." The word *karna* degenerated into *kona* in the *Prākṛita* languages. So in the *Ardha Māgadhi* work *Sūryaprajñapti*,² we get the names *trikona* (= "trigonon"), *catuskona* (= "tetragonon"), *pañcakona* (= "pentagon") etc. These terms are, however, accepted in later Sanskrit literature.³ The term *aśra* or *asīa* in a compound name sometimes denotes the "side." Thus *Baudhāyana* once described a square as *catuhsrakṭi* ("four-cornered") and *sama caturasra* ("equi-four-sided").⁴ So the terms *tryasra*, *caturasīa*, etc., will also mean respectively "trilateral," "quadrilateral," etc.⁵ Thus we get a second system of naming rectilinear geometrical figures according to the number of sides they possess.

An isosceles triangle is denoted by the term *prauga*. This word is probably derived from *pīa* + *yuga*, meaning "the forepart of the shafts of a chariot." A rhombus is similarly called *ubhayataḥ prauga* ("prauga on both sides") inasmuch as it is divided into two *praugas* by a diagonal. Both these terms are as old as the *Taittirīya Samhitā*.⁶

¹ *KSIP*, iv 78

² *Sūryaprajñapti*, Sūtra 19, 25

³ See for instance, the *Parīśistas* of the *Atharva-veda*, xxiii 15, xxv 1, 3, 6, 7, etc., *Arthasāstra* of *Kautilya*, ii 11 29

⁴ *BSI*, i 79

⁵ Cf. *ĀpS*, xx 12

⁶ *TS*, v 4 11

and continued to be used in the same sense in posterior works the *Brahmana* and *Srauta* including *Sulba*

A square is generally called *sama caturasra* (*sama* = equal) It is oftentimes of course when there is no chance of ambiguity the context being clear shortened into *caturasra* ¹ and occasionally even into simple *sama* ² Thibaut is responsible for the opinion that in the term *sama caturasra* the word *sama* refers to the equality of four sides and *caturasra* implies that the four angles of the figure are right angles ³ A more plausible interpretation would be that *sama* refers to the form or shape of the figure which is to be the same in every respect *caturasra* implying a quadrangle or quadrilateral It will then be consistent with the term *dirgha caturasra* for the rectangle ⁴ which signifies that the form of the *caturasra* is in this case *dirgha* (or longish) The rectangle is sometimes called in short the *dirgha* ⁵ The term for a quadrilateral of unequal sides is the *visama caturasra* (literally in equilateral quadrilateral) But in contradistinction from the *sama caturasra* or the square that term may denote also the rectangle ⁶

When all the angles of a polygon are equal it is said to be of *eka karna* (literally one angled) variety and when not so of *dvī karna* (literally two angled) variety implying that in this variety the angles of the figure are of more than one size) ⁷

The diagonal is called the *aksna* or *aksnaya* (that which goes across or transversely that is the cross

¹ BSI 50 51 IpSI 5 4 5 t

² ApSI 5

³ Th b t S l v t s p 7

⁴ BSI 36 33 IpSI 7 1 etc.

⁵ ApSI 4

⁶ Sc ASI 4

⁷ V d p p 81 foot t

line'')¹ In relation to the instrument of measurement, it is sometimes designated as the *aksnayā-rajju* ("the diagonal cord")² and at other times the *aksnayā-venu* ("the diagonal bamboo-rod")³ The diagonal is also denoted by *karna*, meaning "the line going across the angle" or "the line going across from corner to corner"⁴

Circle —In the *Sulba*, the circle is designated the *mandala* ("round"),⁵ *pan-mandala* ("round on all sides")⁶, the circumference, *parimāha*⁷ ("bounding line on all sides"), and the diameter, *viskambha*⁸ or *vyāsa* ("breadth") The centre of the circle is called *madhya* ("middle")- But this term is also used in more general sense for the middlemost point of a square or rectangle,⁹ or of a line¹⁰ The segment of the circle is denoted by the term *pradhī*¹¹

It is perhaps noteworthy that the direction of rotation was used to be indicated in the Vedic Age by means of an

¹ *BŚI*, i 52, iii 55 65, *BŚr*, x 19, xiv 1 Compare *RV*, viii 7 35, *ĀpŚI*, ii 5

Rāma, the commentator of the *Kātyāyana Sulba*, is of opinion that this line is so called because it divides the figure into two *akṣa* or "eyes",

“अन्वित नयति चेचमक्षया चतुरस्रे कोणात् प्रतिकोण नीता हि मध्य-
रज्जुचतुरस्रमचिद्विरूपता नयति । तथा अन्विष्यति तिर्यङ्मानोपार्श्वमान्यन्ती
नीताक्षया भवति ।” *KŚI*, ii 7 (Com)

² *BŚI*, i 50, *ĀpŚI*, i 325

³ *ĀpŚI*, ix 3

⁴ *BŚr*, xix 1, *KŚr*, xvii 6 3

⁵ *BŚI*, i 23, 24, 58, 59, *ĀpŚI*, iii 2, 3

⁶ *ĀpŚI*, vii 6 13, *BŚI*, ii 63 70

⁷ *BŚI*, i 113

⁸ *BŚI*, i 23, 25, 26, *ĀpŚI*, iii, *ApŚI*, vii 10

⁹ *BŚI*, i 58, *ĀŚI* iii 2

¹⁰ *BŚI*, i 56, 57, 73, *ApŚI*, ii 1

¹¹ *BŚI*, ii 71-2

arc of a circle very likely with an arrow head at one extremity. Thus we have the terms *dakṣinaṃṛta lekha* (the line turning rotationally towards the right) and *savyaṃṛta lekha* (the line turning rotationally towards the left)¹. Again a rotation is called *dakṣina praṭ* if it is towards the east by the south and *daśina praṭyaṭ* if it is towards the west by the south².

Area—In the early Hindu geometry a figure is generally denoted by the term *śeṭra*³ and its area by *bhūmi*⁴. Occasionally however the term *śeṭra* is employed also in the sense of an area⁵.

Fundamental Operations—Addition is called *samasa* (putting together) and the sum obtained *samasta* (whole total)⁶. Subtraction is called *nirhara* (deduction) and the remainder *śeṣa*⁶. Division is *bhaga vibhaga*. One term deserves special notice it is *abhyasa*. This word formed from *abhi* and *asa* means radically repetition reduplication. It then came to denote in its various declinations the operation of addition⁷ as well as of multiplication⁸. Whence it seems that the early Hindus recognised multiplication to be a kind of addition.

¹ BŚl 11 30 31

² ĀpŚl v 9 10

³ BŚ x 7 9

⁴ BŚ xx 5 BŚl 56 57 8 ĀpŚl 5 KŚl i 11

⁵ 8 BŚl i 59 ĀpŚl 4

⁶ BŚl 58 ĀpŚl 6 7

⁷ BŚl i 4 9 11 ĀpŚl 9 1

⁸ ĀpŚl 3

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¹ In the collection of the Calcutta University, there is a good number of transcripts of the works on the *Sulba* and their commentaries We have noted below, along with them, the original manuscripts from which they have been transcribed The key to the abbreviations used is as follows

Ady Lib =Library of the Theosophical Society at Adyar, Southern India

Asiat Soc Ben =Asiatic Society of Bengal, Calcutta

Bhand O Inst =Bhandarkar Oriental Institute, Poona

Bom Br Roy Asiat Soc =Bombay Branch of the Royal Asiatic Society, Bombay

Bom Univ =Bombay University

Ind Off Lib =Library of the India Office at London

Mad O Ms Lib =Government Oriental Manuscripts Library, Madras

Mys O Ms Lib =Government Oriental Manuscripts Library, Mysore

Tanj Pal Lib. =Palace Library of the Mahārāja of Tanjore.

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 the plane and the theory of the connection between the
 complete and partial differential equations.

Reciprocal Polars of Conic Sections (*Premchand Roychand Studentship thesis, 1900*), by Kishnaprasad De, M A
Demy 8vo pp 66 Rs 3

An Introduction to the Theory of Elliptic Functions and Higher Transcendentals, by Ganesh Prasad, M A ,
D Sc , Hardinge Professor of Higher Mathematics,
Calcutta University Royal 8vo pp 110 1928
Rs 3-12

Theory of Fourier Series, by Ganesh Prasad, M A , D Sc
Royal 8vo pp 152 1928 Rs 5-4

From a letter to the Registrar from Professor Henri Lebesgue of the Paris University, Member of the Institute of France (translated into English)

“PARIS,

The 19th October, 1928

SIR

I have the honour to acknowledge the receipt of ‘Six Lectures on recent Researches in the Theory of Fourier Series,’ by M Prof Ganesh Prasad.

I have pleasure in finding in that work a simple and clear exposition of the actual state of advance of certain of the most important problems concerning trigonometrical series. The documentation is true and complete it is only once that I have had occasion to find anything in which the erudition of the author appears to be in default. M Kolomogoroff, pursuing the studies indicated on p 53, has obtained an example of a function of summable square of which the Fourier Series diverges everywhere.

For justifying the enunciation which he gives, M Ganesh Prasad utilises the original demonstration of the first author then he gives a historical note, very interesting by the side of the old demonstration. M Prasad gives always whenever possible, as simple a proof as the question under consideration would allow. Many of these proofs are due to M Prasad himself, for example, that which M Prasad gives on pages 60 61 for a criterion for the summability (C 1) which I enunciated at another time.

M Prasad presents his researches elegant and interesting by which he has carried further the classical work of du Bois Reymond.

From the review by Professor L Bieberbach of the Berlin University in the *Jahresbericht der deutschen Mathematiker-Vereinigung* (translated into English) “The work gives a comprehensive account of the results on the convergence and summability of Fourier Series, things about which the author has also earned merit.”

Six Lectures on the Mean Value Theorem of the Differential Calculus by Ganeshi Prasad M.A. D.Sc.
Hardinge Professor of Higher Mathematics Calcutta University Royal 8vo pp 108 + viii 1931 Rs 3

For a letter to the Registrar from Prof. E. R. Hedrick of the University of California Los Angeles and President of the American Mathematical Society

October 8 1931

Dear Sir

at once
in The
most
of me will

For a letter to the Registrar from Professor A. P. Gleason of the University of Michigan (translated to English)

MICHIGAN

10th December 1931

VERY HONOURED MR. MUKHERJEE

For the send of the beautiful book of Prof. Prasad on the
analysis of the Differential Calculus which has interested
me very deeply I express my respects with thanks.

Khandakhadyakam edited by Pandit Baburam Misra
Jyotishacharyya Demy 8vo pp 217 1925 Rs 2

This book is a monumental work by the great Scholar

H. J. A. T. my

strength and size it seems to become more wakeful and uneasy even in the womb it begins to feel the want of something it does not possess a sensation that seems coeval with man's nature and never leaves him till he dies The embryo even then begins to struggle for a state more marked by pleasure and pain and from about the sixth month begins to give the mother warning of the greater pain she is yet to endure The continuation of pregnancy in woman is usually nine months but there have been many instances when the child has lived that was born at seven and some are found to continue pregnant a month above the usual time When the appointed time approaches the infant that has for some months been giving painful proofs of its existence now begins to increase its efforts for liberty The head is applied downward to the aperture of the womb and by reiterated efforts it endeavours to extend the same the endeavours produce the pain which all women in labour feel in some degree those of strong constitutions the least those most weakly the most severely since we learn that the women of Africa always deliver themselves and are well a few hours after while those of Europe require assistance and recover more slowly Thus the infant still continuing to push with its head forward by the repetition of its endeavours at last succeeds and issues into life The blood which had hitherto passed through the heart now takes a wider circuit and the foramen ovale closes the lungs that had till this time been inactive now first begin their functions the air rushes in to distend them and this produces the first sensation of pain which the infant expresses by a shriek so that the beginning of our lives as well as the end is marked with anguish *

From comparing these accounts we perceive that the most laboured generation is the most perfect and that the animal which in proportion to its bulk takes the longest time for production is always the most complete when finished Of all others man seems the slowest in coming into life as he is the slowest in coming to perfection other animals of the same bulk seldom remain

in the womb above six months, while he continues nine ; and even after his birth appears more than any other to have his state of imbecility prolonged.

We may observe also, that that generation is the most complete in which the fewest animals are produced. Nature, by attending to the production of one at a time, seems to exert all her efforts in bringing it to perfection, but, where this attention is divided, the animals so produced come into the world with partial advantages. In this manner twins are never, at least while infants, so large, or so strong, as those that come singly into the world ; each having, in some measure, robbed the other of its right ; as that support, which Nature meant for one, has been prodigally divided.

In this manner, as those animals are the best that are produced singly, so we find that the noblest animals are ever the least fruitful. These are seen usually to bring forth but one at a time, and to place all their attention upon that alone. On the other hand, all the oviparous kinds produce in amazing plenty, and even the lower tribes of viviparous animals increase in a seeming proportion to their minuteness and imperfection. Nature seems lavish of life in the lower orders of the creation, and, as if she meant them entirely for the use of the nobler races, she appears to have bestowed greater pains in multiplying the number than in completing the kind. In this manner, while the elephant and the horse bring forth but one at a time, the spider and the beetle are seen to produce a thousand, and even among the smaller quadrupeds, all the inferior kinds are extremely fertile ; any one of these being found, in a very few months, to become the parent of a numerous progeny.

In this manner, therefore, the smallest animals multiply in the greatest proportion, and we have reason to thank Providence that the most formidable animals are the least fruitful. Had the lion and the tiger the same degree of fecundity with the rabbit or the rat, all the arts of man would be unable to oppose these fierce invaders, and we should soon perceive them become the tyrants of those who claim the lordship of the creation. But heaven, in this respect, has wisely consulted the advantage of all. It has opposed to man only such enemies as he has art and strength to conquer, and as large animals require proportional supplies, nature was unwilling to give new life, where

it in some measure denied the necessary means of subsistence

In consequence of this pre established order the animals that are endowed with the most perfect methods of generation and bring forth but one at a time seldom begin to procreate till they have almost acquired their full growth On the other hand those which bring forth many engender before they have arrived at half their natural size The horse and the bull come almost to perfection before they begin to generate the hog and the rabbit scarcely leave the nest before they become parents themselves In whatever light therefore we consider this subject we shall find that all creatures approach most to perfection whose generation most nearly resembles that of man The reptile produced from cutting is but one degree above the vegetable The animal produced from the egg is a step higher in the scale of existence that class of animals which are brought forth alive are still more exalted Of these such as bring forth one at a time are the most complete and the foremost of these stands Man *the great master of all* who seems to have united the perfections of all the rest in his formation

CHAP III

THE INFANCY OF MAN

WHEN we take a survey of the various classes of animals and examine their strength their beauty or their structure, we shall find man to possess most of those advantages united which the rest enjoy partially Infinitely superior to all others in the powers of the understanding he is also superior to them in the fitness and proportions of his form He would indeed have been one of the most miserable beings upon earth if with a sentient mind he was so formed as to be incapable of obeying its impulse but nature has otherwise provided as with the most extensive intellects to

command, she has furnished him with a body the best fitted for obedience

In infancy,* however, that mind and this body form the most helpless union in all animated nature; and, if any thing can give us a picture of complete imbecility, it is a man when just come into the world. The infant just born stands in need of all things, without the power of procuring any. The lower races of animals, upon being produced are active, vigorous, and capable of self-support; but the infant is obliged to wait in helpless expectation, and its cries are its only aid to procure subsistence

An infant just born may be said to come from one element into another. For, from the watery fluid in which it was surrounded, it now immergees into air, and its first cries seem to imply how greatly it regrets the change. How much longer it could have continued in a state of almost total insensibility in the womb, is impossible to tell, but it is very probable that it could remain there some hours more. In order to throw some light upon this subject, Mr Buffon so placed a pregnant bitch, as that her puppies were brought forth in warm water, in which he kept them above half an hour at a time. However, he saw no change in the animals thus newly brought forth, they continued the whole time vigorous, and during the whole time, it is very probable that the blood circulated through the same channels through which it passed while they continued in the womb

Almost all animals have their eyes closed,† for some days after being brought into the world. The infant opens them the instant of its birth. However, it seems to keep them fixed and idle; they want that lustre which they acquire by degrees, and if they happen to move, it is rather an accidental gaze, than an exertion of the act of seeing. The light alone seems to make the greatest impression upon them. The eyes of infants are sometimes found turned to the place where it is strongest; and the pupil is seen to dilate and diminish, as in grown persons, in proportion to the quantity it receives. But still the infant is incapable of distinguishing objects, the sense of seeing, like the rest of the senses, require an habit before it becomes any

* Buffon, vol. ix p 173

† Buffon, vol. iv p 173

way serviceable. All the senses must be compared with each other and must be made to correct the defects of one another before they can give just information. It is probable therefore that if the infant could express its own sensations it would give a very extraordinary description of the illusions which it suffers from them. The sight might perhaps be represented as inverting objects or multiplying them the hearing instead of conveying one uniform tone might be said to bring up an interrupted succession of noises and the touch apparently would divide one body into as many as there are fingers that grasped it. But all these errors are lost in one confused idea of existence and it is happy for the infant that it then can make but very little use of its senses when they could serve only to bring it false information.

If there be any distinct sensations those of pain seem to be much more frequent and stronger than those of pleasure. The infant's cries are sufficient indications of the uneasiness it must at every interval endure while in the beginning it has got no external marks to testify its satisfactions. It is not till after forty days that it is seen to smile and not till that time also that tears begin to appear its former expressions of uneasiness being always without them. As to any other marks of the passions the infant being as yet almost without them it can express none of them in its visage which except in the act of crying and laughing is fixed in a settled serenity. All the other parts of the body seem equally relaxed and feeble its motions are uncertain and its postures without choice it is unable to stand upright its limbs are yet bent from the habit which it received from its position in the womb it has not strength enough in its arms to stretch them forward much less to grasp any thing with its hands it rests just in the posture it is laid and if abandoned must continue in the same position.

Nevertheless though this be the description of infancy among mankind in general there are countries and races among whom infancy does not seem marked with such utter imbecility but where the children not long after they are born appear possessed of a greater share of self support. The children of negroes have a surprising degree of this premature industry they are able to walk at two months or

at least, to move from one place to another · they also hang to the mother's back without any assistance, and seize the breast over her shoulder ; continuing in this posture till she thinks proper to lay them down This is very different in the children of our countries, that seldom are able to walk under a twelvemonth

The skin of children newly brought forth is always red, proceeding from its transparency, by which the blood beneath appears more conspicuous. Some say that this redness is greatest in those children that are afterwards about to have the finest complexions ; and it appears reasonable that it should be so, since the thinnest skins are always the fairest The size of a new-born infant is generally about twenty inches, and its weight about twelve pounds The head is large, and all the members delicate, soft, and puffy These appearances alter with its age ; as it grows older, the head becomes less in proportion to the rest of the body, the flesh hardens, the bones, that before birth grew very thick in proportion, now lengthen by degrees, and the human figure more and more acquires its due dimensions In such children, however, as are but feeble or sickly, the head always continues too big for the body, the heads of dwarfs being extremely large in proportion

Infants, when newly born, pass most of their time in sleeping, and awake with crying ; excited either by sensations of pain or of hunger Man, when come to maturity, but rarely feels the want of food, as eating twice or thrice in the four and twenty hours is known to suffice the most voracious . but the infant may be considered as a little glutton, whose only pleasure consists in its appetite, and this, except when it sleeps, it is never easy without satisfying Thus nature has adapted different desires to the different periods of life ; each as it seems most necessary for human support or succession While the animal is yet forming, hunger excites it to that supply which is necessary for its growth, when it is completely formed, a different appetite takes place, that incites it to communicate existence These two desires take up the whole attention of different periods, but are very seldom found to prevail strongly together in the same age ; one pleasure ever serving to repress the other . and, if we find a person of full age placing a principal part of his happiness in the nature and quantity of his food, we have

strong reasons to suspect that with respect to his other appetites he still retains a part of the imbecility of his childhood

It is extraordinary however that infants who are thus more voracious than grown persons are nevertheless more capable of sustaining hunger We have several instances in accidental crises of famine in which the child has been known to survive the parent and seen clinging to the breast of its dead mother Their little bodies also are more patient of cold and we have similar instances of the mothers perishing in the snow while the infant has been found alive beside her However if we examine the internal structure of infants we shall find an obvious reason for both these advantages Their blood vessels are known to be much larger than in adults and their nerves much thicker and softer thus being furnished with a more copious quantity of juices, both of *the infant finds a*
 temporary *does not expire*
 till both *so being larger*
 and quicker supplies it with proportionable warmth so that it is more capable of resisting the accidental rigours of the weather

The first nourishment of infants is well known to be the mother's milk and what is remarkable the infant has milk in its own breasts which may be squeezed out by compression this nourishment becomes less grateful as the child gathers strength and perhaps also more unwholesome However in cold countries which are unfavourable to propagation and where the female has seldom above three or four children at the most during her life she continues to suckle the child for four or five years together In this manner the mothers of Canada and Greenland are often seen suckling two or three children of different ages at a time

The life of infants is very precarious till the age of three or four from which time it becomes more secure and when a child arrives at its seventh year it is then considered as a more certain life as Mr Buffon asserts than at any other age whatever It appears from Simpson's Tables that of a certain number of children born at the same time a fourth part are found dead at the end of the first year more than one third at the end of the second and at least half at

the end of the third: so that those who live to be above three years old, are indulged a longer term than half the rest of their fellow-creatures. Nevertheless, life, at that period, may be considered as mere animal existence; and rather a preparation for, than an enjoyment of, those satisfactions, both of mind and body, that make life of real value: and hence it is more natural for mankind to deplore a fellow-creature, cut off in the bloom of life, than one dying in early infancy. The one, by living up to youth, and thus wading through the disadvantageous parts of existence, seems to have earned a short continuance of its enjoyments. the infant, on the contrary, has served but a short apprenticeship to pain; and when taken away, may be considered as rescued from a long continuance of misery

There is something very remarkable in the growth of the human body *. The embryo in the womb continues to increase still more and more till it is born. On the other hand, the child's growth is less every year, till the time of puberty, when it seems to start up of a sudden. Thus, for instance, the embryo, which is an inch long in the first month, grows but one inch and a quarter in the second; it then grows one and a half in the third, two and a half in the fourth; and in this manner it keeps increasing till in the last month of its continuance it is actually found to grow four inches; and in the whole about eighteen inches long. But it is otherwise with the child when born. if we suppose it eighteen inches at that time, it grows in the first year six or seven inches, in the second year, it grows but four inches; in the third year, about three; and so on, at the rate of about an inch and an half, or two inches, each year, till the time of puberty, when nature seems to make one great last effort, to complete her work, and unfold the whole animal machine

The growth of the mind in children seems to correspond with that of the body. The comparative progress of the understanding is greater in infants than in children of three or four years old. If we only reflect a moment on the amazing acquisitions that an infant makes in the first and second years of life, we shall have much cause for wonder. Being sent into a world where every thing is new and unknown,

the first months of life are spent in a kind of torpid amazement an attention distracted by the multiplicity of objects that press to be known The first labour therefore of the little learner is to correct the illusions of the senses to distinguish one object from another and to exert the memory so as to know them again In this manner a child of a year old has already made a thousand experiments all which it has properly ranged and distinctly remembers Light heat fire sweets and bitters sounds soft or terrible are all distinguished at the end of a very few months Besides this every person the child knows every individual object it becomes fond of its rattles or its bells may be all considered as so many new lessons to the young mind with which it has not become acquainted without repeated exertions of the understanding At this period of life the knowledge of every individual object cannot be acquired without the same effort which when grown up is employed upon the most abstract idea every thing the child hears or sees all the marks and characters of nature are as much unknown and require the same attention to attain as if the reader were set to understand the characters of an Ethiopic manuscript and yet we see in how short a time the little student begins to understand them all and to give evident marks of early industry

It is very amusing to pursue the young mind while employed in its first attainments At about a year old the same necessities that first engaged its faculties increase as its acquaintance with nature enlarges Its studies therefore if I may use the expression are no way relaxed for having experienced what gave pleasure at one time it desires a repetition of it from the same object and in order to obtain this that object must be pointed out here therefore a new necessity arises which very often neither its little arts nor importunities can remove so that the child is at last obliged to set about naming the objects it desires to possess or avoid In beginning to speak which is usually about a year old children find a thousand difficulties It is not without repeated trials that they come to pronounce any one of the letters nor without an effort of the memory that they can retain them For this reason we frequently see them attempting a sound which they had learned but forgot and when they have failed I have often seen their

attempt attended with apparent confusion The letters soonest learned, are those which are most easily formed; thus A and B require an obvious disposition of the organs, and their pronunciation is consequently soon attained Z and R, which require a more complicated position, are learned with greater difficulty And this may, perhaps, be the reason why the children in some countries speak sooner than in others; for the letters mostly occurring in the language of one country, being such as are of easy pronunciation, that language is of course more easily attained. In this manner the children of the Italians are said to speak sooner than those of the Germans, the language of the one being smooth and open; that of the other, crowded with consonants, and extremely guttural.

But be this as it will, in all countries children are found able to express the greatest part of their wants by the time they arrive at two years old; and from the moment the necessity of learning new words ceases, they relax their industry. It is then that the mind, like the body, seems every year to make slow advances; and, in order to spur up attention, many systems of education have been contrived.

Almost every philosopher, who has written on the education of children, has been willing to point out a method of his own, chiefly professing to advance the health, and improve the intellects at the same time. These are usually found to begin with finding nothing right in the common practice; and by urging a total reformation In consequence of this, nothing can be more wild or imaginary than their various systems of improvement Some will have the children every day plunged in cold water, in order to strengthen their bodies, they will have them converse with the servants in nothing but the Latin language, in order to strengthen their minds, every hour of the day must be appointed for its own studies, and the child must learn to make these very studies an amusement, till about the age of ten or eleven it becomes a prodigy of premature improvement. Quite opposite to this, we have others, whom the courtesy of mankind also calls *philosophers*, and they will have the child learn nothing till the age of ten or eleven, at which the former has attained so much perfection; with them the mind is to be kept empty, until it

has a proper distinction of some metaphysical ideas about truth and the promising pupil is debarred the use of even his own faculties lest they should conduct him into prejudice and error. In this manner some men whom fashion has celebrated for profound and fine thinkers have given their hazarded and untried conjectures upon one of the most important subjects in the world and the most interesting to humanity. When men speculate at liberty upon innate ideas or the abstracted distinctions between will and power they may be permitted to enjoy their systems at pleasure as they are harmless although they may be wrong but when they allege that children are to be every day plunged in cold water and whatever be their constitutions indiscriminately inured to cold and moisture that they are to be kept wet in the feet to prevent their catching cold and never to be corrected when young for fear of breaking their spirits when old, these are such noxious errors that all reasonable men should endeavour to oppose them. Many have been the children whom these opinions begun in speculation have injured or destroyed in practice and I have seen many a little philosophical martyr whom I wished but was unable, to relieve.

If any system be therefore necessary it is one that would serve to shew a very plain point, that very little system is necessary. The natural and common course of education is in every respect the best. I mean that in which the child is permitted to play among its little equals from whose similar instructions it often gains the most useful stores of knowledge. A child is not idle because it is playing about the fields or pursuing a butterfly it is all this time storing its mind with objects upon the nature the properties and the relations of which future curiosity may speculate.

I have ever found it a vain task to try to make a child's learning its amusement nor do I see what good end it would answer were it actually attained. The child as was said ought to have its share of play and it will be benefited thereby and for every reason also it ought to have its share of labour. The mind by early labour will be thus accustomed to fatigues and subordination and whatever be the person's future employment in life he

will be better fitted to endure it: he will be thus enabled to support the drudgeries of office with content; or to fill up the vacancies of life with variety. The child, therefore, should by times be put to its duty; and be taught to know, that the task is to be done, or the punishment to be endured. I do not object against alluring it to duty by reward; but we well know, that the mind will be more strongly stimulated by pain; and both may, upon some occasions, take their turn to operate. In this manner, a child, by playing with its equals abroad, and labouring with them at school, will acquire more health and knowledge, than by being bred up under the wing of any speculative system-maker; and will be thus qualified for a life of activity and obedience. It is true, indeed, that when educated in this manner, the boy may not be so seemingly sensible and forward as one bred up under solitary instruction; and, perhaps, this early forwardness is more engaging than useful. It is well known, that many of those children who have been such prodigies of literature before ten, have not made an adequate progress to twenty. It should seem, that they only began learning manly things before their time; and, while others were busied in picking up that knowledge adapted to their age and curiosity, these were forced upon subjects unsuited to their years; and, upon that account alone, appearing extraordinary. The stock of knowledge in both may be equal; but with this difference, that each is yet to learn what the other knows.

But whatever may have been the acquisitions of children at ten or twelve, their greatest, and most rapid progress, is made when they arrive near the age of puberty. It is then that all the powers of nature seem at work in strengthening the mind and completing the body; the youth acquires courage, and the virgin modesty; the mind, with new sensations, assumes new powers; it conceives with greater force, and remembers with greater tenacity. About this time, therefore, which is various in different countries, more is learned in one year than in any two of the preceding; and on this age, in particular, the greatest weight of instruction ought to be thrown

CHAP IV

OF PUBERTY

It has been often said that the season of youth is the season of pleasures but this can only be true in savage countries where but little preparation is made for the perfection of human nature and where the mind has but a very small part in the enjoyment It is otherwise in those places where nature is carried to the highest pitch of refinement in which this season of the greatest sensual delight is wisely made subservient to the succeeding and more rational one of manhood Youth with us is but a scene of preparation

of life of their share so that his eagerness only produces a manhood of imbecility and an age of pain

The time of puberty is different in various countries and always more late in men than in women In the warm countries of India the women are marriageable at nine or ten and the men at twelve or thirteen It is also different in cities where the inhabitants lead a more soft luxurious life from the country where they work harder and fare less delicately Its symptoms are seldom alike in different persons but it is usually known by a swelling of the breasts in one sex and a roughness of the voice in the other At this season also the women seem to acquire new beauty while the men lose all that delicate effeminacy of countenance which they had when boys

All countries in proportion as they are civilized or barbarous improve or degrade the nuptial satisfaction In those miserable regions where strength makes the only law the stronger sex exerts its power and becomes the tyrant over the weaker while the inhabitant of Negroland is indolently taking his pleasure in the fields his wife is obliged to till the ground that serve for their mutual support It is thus in

all barbarous countries, where the men throw all the laborious duties of life upon the women ; and, regardless of beauty, put the softer sex to those employments that must effectually destroy it.

But, in countries that are half barbarous, particularly wherever Mahometanism prevails, the men run into the very opposite extreme. Equally brutal with the former, they exert their tyranny over the weaker sex, and consider that half of the human creation as merely made to be subservient to the depraved desires of the other. The chief, and, indeed, the only aim of an Asiatic, is to be possessed of many women ; and to be able to furnish a seraglio is the only tendency of his ambition. As the savage was totally regardless of beauty, he, on the contrary, prizes it too highly ; he excludes the person who is possessed of such personal attractions from any share in the duties or employments of life ; and, as if willing to engross all beauty to himself, increases the number of his captives in proportion to the progress of his fortune. In this manner he vainly expects to augment his satisfactions, by seeking from many that happiness which he ought to look for in the society of one alone. He lives a gloomy tyrant, amidst wretches of his own making ; he feels none of those endearments which spring from affection, none of those delicacies which arise from knowledge. His mistresses, being shut out from the world, and totally ignorant of all that passes there, have no arts to entertain his mind, or calm his anxieties ; the day passes with them in sullen silence, or languid repose ; appetite can furnish but few opportunities of varying the scene ; and all that falls beyond it must be irksome expectation.

From this avarice of women, if I may be allowed to express it so, has proceeded that jealousy and suspicion which ever attends the miser hence those low and barbarous methods of keeping the women of those countries guarded, and of making and procuring eunuchs to attend them. These unhappy creatures are of two kinds, the white and the black. The white are generally made in the country where they reside, being but partly deprived of the marks of virility ; the black are generally brought from the interior parts of Africa, and are made entirely bare. These are chiefly chosen for their deformity ; the thicker the lips, the

flatter the nose and the more black the teeth the more valuable the eunuch so that the vile jealousy of mankind here inverts the order of nature and the poor wretch finds himself valued in proportion to his deficiencies In Italy where this barbarous custom is still retained and eunuchs are made in order to improve the voice the laws are severely aimed against such practice so that being entirely prohibited none but the poorest and most abandoned of the people still secretly practise it upon their children Of those served in this manner not one in ten is found to become a singer but such is the luxurious folly of the times that the success of one amply compensates for the failure of the rest It is very difficult to account for the alterations which castration makes in the voice and the other parts of the body The eunuch is shaped differently from others His legs are of an equal thickness above and below his knees weak his shoulders narrow and his beard thin and downy In this manner his person is rendered more deformed but his desires as I am told still continue the same and actually in Asia some of them are found to have their seraglios as well as their masters Even in our country we have an instance of a very fine woman being married to one of them whose appearance was the most unpromising and what is more extraordinary still I am told that this couple continue perfectly happy in each other's society

The mere necessities of life seem the only aim of the savage the sensual pleasures are the only study of the semi barbarian but the refinement of sensuality by reason is the boast of real politeness Among the merely barbarous nations such as the natives of Madagascar or the inhabitants of Congo nothing is desired so ardently as to prostitute their wives or daughters to strangers for the most trifling advantages they will account it a dishonour not to be among the foremost who are thus received into favour on the other hand the Mahometan keeps his wife faithful by confining her person and would instantly put her to death if he but suspected her chastity With the politer inhabitants of Europe both these barbarous extremes are avoided the woman's person is left free and no constraint is imposed but upon her affections The passion of love which may be considered as the nice conduct

of ruder desire, is only known and practised in this part of the world; so that what other nations guard as their right, the more delicate European is contented to ask as a favour. In this manner the concurrence of mutual appetite contributes to increase mutual satisfaction; and the power on one side of refusing, makes every blessing more grateful when obtained by the other. In barbarous countries woman is considered merely as an useful slave, in such as are somewhat more refined, she is regarded as a desirable toy, in countries entirely polished, she enjoys juster privileges, the wife being considered as an useful friend, and an agreeable mistress. Her mind is still more prized than her person; and without the improvement of both, she can never expect to become truly agreeable; for her good sense alone can preserve what she has gained by her beauty.

Female beauty, as was said, is always seen to improve about the age of puberty. but if we should attempt to define in what this beauty consists, or what constitutes its perfection, we should find nothing more difficult to determine. Every country has its peculiar way of thinking, in this respect; and even the same country thinks differently at different times. The Ancients had a very different taste from what prevails at present. The eye-brows joining in the middle was considered as a very peculiar grace by Tibullus, in the enumeration of the charms of his mistress. Narrow foreheads were approved of, and scarce any of the Roman ladies, that are celebrated for their other perfections, but are also praised for the redness of their hair. The nose also of the Grecian Venus, was such as would appear at present an actual deformity, as it fell in a straight line from the forehead, without the smallest sinking between the eyes, without which we never see a face at present.

Among the moderns, every country seems to have peculiar ideas of beauty.* The Persians admire large eye-brows, joining in the middle, the edges and corners of the eyes are tinged with black, and the size of the head is increased by a great variety of bandages, formed into a turban. In some parts of India, black teeth and white

* Buffon

hair are desired with ardour and one of the principal employments of the women of Thibet, is to redden the teeth with herbs and to make their hair white by a certain preparation. The passion for coloured teeth obtains also in China and Japan where to complete their idea of beauty the object of desire must have little eyes nearly closed feet extremely small and a waist far from being shapely. There are some nations of the American Indians that flatten the heads of their children by keeping them while young squeezed between two boards, so as to make the visage much larger than it would naturally be. Others flatten the head at top and others make it as round as they possibly can. The inhabitants along the western coasts of Africa have a very extraordinary taste for beauty. A flat nose thick lips and a jet black complexion are there the most indulgent gifts of nature. Such indeed they are all in some degree found to possess. However they take care by art to increase their natural deformities as they should seem to us and they have many additional methods of rendering their persons still more frightfully pleasing. The whole body and visage is often scarred with a variety of monstrous figures which is not done without great pain and repeated incision and even sometimes parts of the body are cut away. But it would be endless to remark the various arts which caprice or custom has employed to distort and disfigure the body in order to render it more pleasing in fact every nation how barbarous soever seems unsatisfied with the human figure as Nature has left it and has its peculiar arts of heightening beauty. Painting powdering cutting boring the nose and the ears lengthening the one and depressing the other are arts practised in many countries and in some degree admired in all. These arts might have been at first introduced to hide epidemic deformities custom by degrees reconciles them to the view till from looking upon them with indifference the eye at length begins to gaze with pleasure.

CHAP V

OF THE AGE OF MANHOOD *

THE human body attains to its full height during the age of puberty, or, at least, a short time after. Some young people are found to cease growing at fourteen or fifteen, others continue their growth till two or three and twenty. During this period they are all of a slender make, their thighs and legs small, and the muscular parts are yet unfilled. But by degrees the fleshy fibres augment, the muscles swell, and assume their figure, the limbs become proportioned, and rounder, and before the age of thirty, the body in men has acquired the most perfect symmetry. In women, the body arrives at perfection much sooner, as they arrive at the age of maturity more early, the muscles, and all the other parts, being weaker, less compact and solid, than those of man, they require less time in coming to perfection, and, as they are less in size, that size is sooner completed. Hence the persons of women are found to be as complete at twenty, as those of men are found to be at thirty.

The body of a well-shaped man ought to be square, the muscles should be expressed with boldness, and the lines of the face strongly marked. In the woman, all the muscles should be rounder, the lines softer, and the features more delicate. Strength and majesty belong to the man, grace and softness are the peculiar embellishments of the other sex. In both every part of their form declares their sovereignty over other creatures. Man supports his body erect; his attitude is that of command, and his face, which is turned towards the heavens, displays the dignity of his

* This chapter is translated from Mr Buffon, whose description is very excellent. Whatever I have added is marked by inverted commas, "thus." And in whatever trifling points I have differed, the notes will serve to shew

station The image of his soul is painted in his visage and the excellence of his nature penetrates through the material form in which it is enclosed His majestic port his sedate and resolute step announce the nobleness of his rank He touches the earth only with his extremity and beholds it as if at a disdainful distance His arms are not given him as to other creatures for pillars of support nor does he lose by rendering them callous against the ground that delicacy of touch which furnishes him with so many of his enjoyments His hands are made for very different purposes to second every intention of his will and to perfect the gifts of Nature

When the soul is at rest all the features of the visage seem settled in a state of profound tranquillity Their proportion their union and their harmony seem to mark the sweet serenity of the mind and give a true information of what passes within But when the soul is excited the human visage becomes a living picture where the passions are expressed with as much delicacy as energy where every motion is designed by some correspondent feature where every impression anticipates the will and betrays those hidden agitations that he would often wish to conceal

It is particularly in the eyes that the passions are painted and in which we may most readily discover their beginning The eye seems to belong to the soul more than any other organ it seems to participate of all its emotions as well as the most soft and tender as the most tumultuous and forceful It not only receives but transmits them by sympathy the observing eye of one catches the secret fire from another and the passion thus often becomes general

Such persons as are short sighted labour under a particular disadvantage in this respect They are in a manner entirely cut off from the language of the eyes and this gives an air of stupidity to the face which often produces very unfavourable prepossessions However intelligent we find such persons to be we can scarcely be brought back from our first prejudice and often continue in the first erroneous opinion In this manner we are too much induced to judge of men by their physiognomy and having perhaps at first caught up our judgments prematurely they mechanically influence us all our lives after This extends even to the very colour or the cut of people's clothes and

we should for this reason be careful, even in such trifling particulars, since they go to make up a part of the total judgment which those we converse with may form to our advantage.

The vivacity, or the languid motion of the eyes, give the strongest marks of physiognomy, and their colour contributes still more to enforce the expression. The different colours of the eye are the dark hazel, the light hazel, the green, the blue and gray, the whitish gray, "and also the red." These different colours arise from the different colours of the little muscles that serve to contract the pupil, "and they are very often found to change colour with disorder, and with age."

The most ordinary colours are the hazel and the blue, and very often both these colours are found in the eyes of the same person. Those eyes which are called black, are only of the dark hazel, which may be easily seen upon close inspection, however, those eyes are reckoned the most beautiful where the shade is the deepest and either in these, or the blue eyes, the fire, which gives its finest expression to the eye, is more distinguishable in proportion to the darkness of the tint. For this reason, the black eyes, as they are called, have the greatest vivacity, but, probably, the blue have the most powerful effect in beauty, as they reflect a greater variety of lights, being composed of more various colours.

This variety, which is found in the colour of the eyes, is peculiar to man, and one or two other kinds of animals, but, in general, the colour in any one individual is the same in all the rest. The eyes of oxen are brown, those of sheep of a water colour, those of goats are gray "and it may also be, in general, remarked that the eyes of most white animals are red, thus the rabbit, the ferret, and, even in the human race, the white Moor, all have their eyes of a red colour."

Although the eye, when put into motion, seems to be drawn on one side, yet it only moves round the centre, by which its coloured part moves nearer or farther from the angle of the eye-lids, or is elevated or depressed. The distance between the eyes is less in man than in any other animal; and in some of them it is so great, that it is impossible that they should ever view the same object with both eyes at

once unless it be very far off. This however in them is rather an advantage than an inconvenience as they are thus able to watch round them and guard against the dangers of their precarious situation.

Next to the eyes the features which most give a character to the face are the eye brows which being in some measure more apparent than the other features are most readily distinguished at a distance. Le Brun in giving a painter directions with regard to the passions places the principal expression of the face in the eye brows. From their elevation or depression most of the furious passions are characterized and such as have this feature extremely moveable are usually known to have an expressive face. By means of these we can imitate all the other passions as they are raised or depressed at command the rest of the features are generally fixed or when put into motion they do not obey the will the mouth and eyes in an actor for instance may by being violently distorted give a very different expression from what he would intend but the eye brows can scarcely be exerted improperly their being raised denotes all those passions which pride or pleasure inspire and their depression marks those which are the effects of contemplation and pain and such who have this feature therefore most at command are often found to excel as actors.

The eye lashes have an effect in giving expression to the eye particularly when long and close they soften its glances and improve its sweetness. Man and apes are the only animals that have eye lashes both upon the upper and lower lids all other animals want them on the lid below.

The eye lids serve to guard the ball of the eye and to furnish it with a proper moisture. The upper lid rises and falls the lower has scarcely any motion and although their being moved depends on the will yet it often happens that the will is unable to keep them open when sleep or fatigue oppresses the mind. In birds and amphibious quadrupeds the lower lid alone has motion fishes and insects have no eye lids whatsoever.

The forehead marks a large part of the face and a part which chiefly contributes to its beauty. It ought to be justly proportioned neither too round nor too flat neither too

narrow nor too low; and the hair should come thick upon its extremities. It is known to every body how much the hair tends to improve the face, and how much the being bald serves to take away from beauty. The highest part of the head is that which becomes bald the soonest, as well as that part which lies immediately above the temples. The hair under the temples, and at the back of the head, is very seldom known to fall, "and women are much less apt to become bald than men: Mr Buffon seems to think they never become bald at all, but we have too many instances of the contrary among us not to contradict very easily the assertion. Of all parts or appendages of the body, the hair is that which is found most different, in different climates, and often not only contributes to mark the country, but also the disposition of the man. It is in general thickest where the constitution is strongest, and more glossy and beautiful, where the health is most permanent. The ancients held the hair to be a sort of excrement, produced like the nails, the part next the root pushing out that immediately contiguous. But the moderns have found that every hair may be truly said to live, to receive nutriment, to fill and distend itself, like the other parts of the body. The roots, they observe, do not turn gray sooner than the extremities, but the whole hair changes colour at once, and we have many instances of persons who have grown gray in one night's time.* Each hair, if viewed with a microscope, is found to consist of five or six lesser ones, all wrapped up in one common covering; it appears knotted, like some sorts of grass, and sends forth branches at the joints. It is bulbous at the root, by which it imbibes its moisture from the body, and it is split at the points, so that a single hair, at its ends, resembles a brush. Whatever be the size or the shape of the pore, through which the hair issues, it accommodates itself to the same, being either thick, as they are large, small, as they are less; round, triangular, and variously formed, as the pores happen to be various. The hair takes its colour from the juices flowing through it, and it is found that this colour differs in dif-

* Mr Buffon says, that the hair begins to grow gray at the points, but the fact is otherwise.

ferent tribes and races of people The Americans and the Asiatics have their hair black thick straight and shining The inhabitants of the torrid climates of Africa have it black short and woolly The people of Scandinavia have it red long and curled and those of our own and the neighbouring countries are found with hair of various colours However it is supposed by many that every man resembles in his disposition the inhabitants of those countries whom he resembles in the colour and the nature of his hair so that the black are said like the Asiatics to be grave and acute the red like the Gothic nations to be choleric and bold However this may be the length and the strength of the hair is a general mark of a good constitution and as that hair which is strongest is most commonly curled so curled hair is generally regarded among us as a beauty The Greeks however had a very different idea of beauty in this respect and seem to have taken one of their peculiar national distinctions from the length and the straightness of the hair

The nose is the most prominent feature in the face but as it has scarcely any motion and that only in the strongest passions it rather adds to the beauty than to the expression of the countenance However I am told by the skilful in this branch of knowledge that wide nostrils add a great deal to the bold and resolute air of the countenance and where they are narrow though it may constitute beauty it seldom improves expression The form of the nose and its advanced position are peculiar to the human visage alone Other animals for the most part have nostrils with a partition between them but none of them have an elevated nose Apes themselves have scarcely any thing else of this feature but the nostrils the rest of the feature lying flat upon the visage and scarcely higher than the cheek bones Among all the tribes of savage men also the nose is very flat and I have seen a Tartar who had scarcely any thing else but two holes through which to breathe

The mouth and lips next to the eyes are found to have the greatest expression The passions have great power over this part of the face and the mouth marks its different degrees by its different forms The organ of speech still more animates this part and gives it more life than

any other feature in the countenance The ruby colour of the lips, and the white enamel of the teeth, give it such a superiority over every other feature, that it seems to make the principal object of our regards In fact, the whole attention is fixed upon the lips of the speaker however rapid his discourse, however various the subject, the mouth takes correspondent situations; and deaf men have been often found to see the force of those reasonings which they could not hear, understanding every word as it was spoken

“The under jaw in man possesses a great variety of motions, while the upper has been thought, by many, to be quite immoveable * However, that it moves in man, a very easy experiment will suffice to convince us If we keep the head fixed, with any thing between our teeth, the edge of a table for instance, and then open our mouths, we shall find that both jaws recede from it at the same time, the upper jaw rises, the lower falls, and the table remains untouched between them The upper jaw has motion as well as the under; and, what is remarkable, it has its proper muscles behind the head for thus raising and depressing it Whenever, therefore, we eat, both jaws move at the same time, though very unequally; for the whole head moving with the upper jaw, of which it makes a part, its motions are thus less observable” In the human embryo, the under jaw is very much advanced before the upper “In the adult, it hangs a good deal more backward, and those whose upper and under row of teeth are equally prominent, and strike directly against each other, are what the painters call under-hung, and they consider this as a great defect in beauty † The under jaw in a Chinese face falls greatly more backward than with us, and I am told the difference is half an inch, when the mouth is shut naturally” In instances of the most violent passion, the under jaw has often an involuntary quivering motion, and often also, a state of languor produces another, which is that of yawning “Every one

* Mr Buffon is of this opinion He says that the upper jaw is immoveable in all animals However, the parrot is an obvious exception, and so is man himself, as shewn above

† Mr Buffon says, that both jaws, in a perfect face, should be on a level but this is denied by the best painters

knows how very sympathetic this kind of languid motion is and that for one person to yawn is sufficient to set all the rest of the company yawning. A ridiculous instance of this was commonly practised upon the famous M. Laurin one of the professors at Edinburgh. He was very subject to have his jaw dislocated, so that when he opened his mouth wider than ordinary or when he yawned he could not shut it again. In the midst of his harangues therefore if any of his pupils began to be tired of his lecture he had only to gape or yawn and the professor instantly caught the sympathetic affliction so that he thus continued to stand speechless with his mouth wide open till his servant from the next room was called in to set his jaw again. *

When the mind reflects with regret upon some good unattained or lost it feels an internal emotion which acting upon the diaphragm and that upon the lungs produces a sigh this when the mind is strongly affected is repeated sorrow succeeds these first emotions and tears are often seen to follow sobbing is the sigh still more invigorated and lamentation or crying proceeds from the continuance of the plaintive tone of the voice which seems to implore pity. There is yet a silent agony in which the mind appears to disdain all external help and broods over its distresses with gloomy reserve. This is the most dangerous state of mind accidents or friendship may lessen the louder kinds of grief but all remedies for this must be had from within and there despair too often finds the most deadly enemy.

Laughter is a sound of the voice interrupted and pursued for some continuance. The muscles of the belly and the diaphragm are employed in the slightest exertions but those of the ribs are strongly agitated in the louder and the head sometimes is thrown backward in order to raise them with greater ease. The smile is often an indication of kindness and good will it is also often found used as a mark of contempt and ridicule.

Blushing proceeds from different passions being produced by shame anger pride and joy. Paleness is often

Since the publication of this work the editor has been credibly informed that the professor had not the defect here mentioned.

also the effect of anger ; and almost ever attendant on fright and fear These alterations in the colour of the countenance are entirely involuntary : all the other expressions of the passions are, in some small degree, under control ; but blushing and paleness betray our secret purposes ; and we might as well attempt to stop them, as the circulation of the blood, by which they are caused

The whole head, as well as the features of the face, takes peculiar attitudes from its passions . it bends forward, to express humility, shame, or sorrow, it is turned to one side, in languor or in pity ; it is thrown with the chin forward, in arrogance and pride, erect, in self-conceit and obstinacy ; it is thrown backwards in astonishment ; and combines its motions to the one side and the other, to express contempt, ridicule, anger, and resentment “ Painters, whose study leads to the contemplation of external forms, are much more adequate judges of these than any naturalist can be, and it is with these a general remark, that no one passion is regularly expressed on different countenances in the same manner ; but that grief often sits upon the face like joy, and pride assumes the air of passion. It would be vain, therefore, in words, to express their general effect, since they are often as various as the countenances they sit upon ; and in making this distinction nicely, lies all the skill of the physiognomist In being able to distinguish what part of the face is marked by nature, and what by the mind ; what part has been originally formed, and what is made by habit, constitutes this science, upon which the ancients so much valued themselves, and which we at present so little regard. Some, however, of the most acute men among us, have paid great attention to this art, and, by long practice, have been able to give some character of every person whose face they examine Montaigne is well known to have disliked those men who shut one eye in looking upon any object ; and Fielding asserts, that he never knew a person with a steady glavering smile, but he found him a rogue However, most of these observations, tending to a discovery of the mind by the face, are merely capricious ; and Nature has kindly hid our hearts from each other, to keep us in good humour with our fellow-creatures ”

The parts of the head which give the least expression to the face are the ears and they are generally found hidden under the hair. These which are immovable and make so small an appearance in man are very distinguishing features in quadrupeds. They serve in them as the principal marks of the passions the ears discover their joys or their terrors with tolerable precision and denote all their internal agitations. The smallest ears in men are said to be the most beautiful but the largest are found to be the best for hearing. There are some savage nations who bore their ears and so draw that part down that the tips of the ears are seen to rest upon their shoulders.

The strange variety in the different customs of men appears still more extravagant in their manner of wearing their beards. Some and among others the Turks cut the hair off their heads and let their beards grow. The Europeans on the contrary shave their beards and wear their hair. The Negroes shave their heads in figures at one time in stars at another in the manner of friars and still more commonly in alternate stripes and their little boys are shaved in the same manner. The Ialapouns of Siam shave the heads and the eye brows of such children as are committed to their care. Every nation seems to have entertained different prejudices at different times in favour of one part or another of the beard. Some have admired the hair upon the cheeks on each side as we see with some low bred men among ourselves who want to be fine. Some lift the hair lower down some choose it curled and others like it straght. Some have it cut into a peak and others shave all but the whisker. This particular part of the beard was highly prized among the Spaniards till of late a man without whiskers was considered as unfit for company and where Nature had denied them Art took care to supply the deficiency. We are told of a Spanish general who when he borrowed a large sum of money from the Venetians pawned his whisker which he afterwards took proper care to release. Kingson assures us that a considerable part of the religion of the Tartars consists in the management of their whiskers and that they waged a long and bloody war with the Persians declaring them infidels merely because

they would not give them whiskers the orthodox cut — The kings of Persia carried the care of their beards to a ridiculous excess, when they chose to wear them matted with gold-thread and even the kings of France, of the first races, had them knotted and buttoned with gold. But of all nations, the Americans take the greatest pains in cutting their hair, and plucking their beards. The under part of the beard, and all but the whisker, they take care to pluck up by the roots, so that many have supposed them to have no hair naturally growing on that part, and even Linnæus has fallen into that mistake. Their hair is also cut into bands, and no small care employed in adjusting the whisker. In fact, we have a very wrong idea of savage finery; and are apt to suppose that, like the beasts of the forest, they rise, and are dressed with a shake but the reverse is true; for no birth-night beauty takes more time or pains in the adorning her person than they. I remember, when the Cherokee kings were over here, that I have waited for three hours during the time they were dressing. They never would venture to make their appearance till they had gone through the tedious ceremonies of the toilet they had then boxes of oil and ochre, their fat and then perfumes, like the most effeminate beau, and generally took up four hours in dressing before they considered themselves as fit to be seen. We must not, therefore, consider a delicacy in point of dress, as a mark of refinement, since savages are much more difficult in this particular than the most fashionable or tawdry European. The more barbarous the people, the fonder of finery. In Europe, the lustre of jewels, and the splendour of the most brilliant colours, are generally given up to women, or to the weakest part of the other sex, who are willing to be contemptibly fine but in Asia, these trifling fineries are eagerly sought after by every condition of men, and, as the proverb has it, we find the richest jewels in an Ethiop's ear. The passion for glittering ornaments is still stronger among the absolute barbarians, who often exchange their whole stock of provisions, and whatever else they happen to be possessed of, with our seamen, for a glass-bead, or a looking-glass."

Although fashions have arisen in different countries from fancy and caprice, these, when they become general, deserve

examination. Man kind have always considered it as a matter of moment and they will ever continue desirous of drawing the attention of each other by such ornaments as mark the riches the power or the courage of the wearer. The value of those shining stones which have at all times been considered as precious ornaments is entirely founded upon their scarceness or their brilliancy. It is the same likewise with respect to those shining metals the weight of which is so little regarded when spread over our clothes. These ornaments are rather designed to draw the attention of others than to add to any enjoyments of our own and few there are that these ornaments will not serve to dazzle and who can coolly distinguish between the metal and the man.

All things rare and brilliant will therefore ever continue to be fashionable while men derive greater advantage from opulence than virtue while the means of appearing considerable are more easily acquired than the title to be considered. The first impression we generally make arises from our dress and this varies in conformity to our inclinations and the manner in which we desire to be considered. The modest man or he who would wish to be thought so desires to show the simplicity of his mind by the plainness of his dress the vain man on the contrary takes a pleasure in displaying his superiority and is willing to incur the spectator's dislike so he does but excite his attention.

Another point of view which men have in dressing is to increase the size of their figure and to take up more room in the world than Nature seems to have allotted them. We desire to swell out our clothes by the stiffness of art and raise our heels while we add to the largeness of our heads. How bulky soever our dress may be our vanities are still more bulky. The largeness of the doctor's wig arises from the same pride with the smallness of the beau's queue. Both want to have the size of their understanding measured by the size of their heads.

There are some modes that seem to have a more reasonable origin which is to hide or to lessen the defects of nature. To take men all together there are many more deformed and plain than beautiful and shapely. The former a being the most numerous give law to fashion.

and their laws are generally such as are made in their own favour. The women begin to colour their cheeks with red, when the natural roses are faded; and the younger are obliged to submit, though not compelled by the same necessity. In all parts of the world, this custom prevails more or less; and powdering and frizzing the hair, though not so general, seems to have arisen from a similar control.

But leaving the draperies of the human picture, let us return to the figure, unadorned by art. Man's head, whether considered externally or internally, is differently formed from that of all other animals, the monkey-kind only excepted, in which there is a striking similitude.—There are some differences, however, which we shall take notice of in another place. The bodies of all quadruped animals are covered with hair; but the head of man seems the part most adorned, and that more abundantly than in any other animal.

There is a very great variety in the teeth of all animals; some have them above and below; others have them in the under jaw only; in some they stand separate from each other, while in some they are continued and united. The palate of some fishes is nothing else but a bony plate studded with points, which perform the offices of teeth. All these substances, in every animal, derive their origin from the nerves; the substance of the nerves hardens by being exposed to the air, and the nerves that terminate in the mouth, being thus exposed, acquire a bony solidity. In this manner the teeth and nails are formed in man; and in this manner also, the beak, the hoofs, the horns, and the talons, of other animals, are found to be produced.

The neck supports the head, and unites it to the body. This part is much more considerable in the generality of quadrupeds, than in man. But fishes, and other animals that want lungs similar to ours, have no neck whatsoever. Buds, in general, have the neck longer than any other kind of animals: those of them which have short claws, have also short necks; those, on the contrary, that have them long, are found to have the neck in proportion.—“In men, there is a lump upon the wind-pipe, formed by the thyroid cartilage, which is not to be seen in women.

an Arabian fable says that this is a part of the original apple that has stuck in the man's throat by the way but that the woman swallowed her part of it down

The human breast is outwardly formed in a very different manner from that of other animals. It is larger in proportion to the size of the body and none but man and such animals as make use of their fore feet as hands such as monkeys bats and squirrels and such quadrupeds as climb trees are found to have those bones called the *clavicles* or as we usually term them the *collar bones* *. The breasts in women are larger than in men however they seem formed in the same manner and sometimes milk is found in the breasts of men as well as in those of women. Among animals there is a great variety in this part of the body. The teats of some as in the ape and the elephant are like those of men being but two and placed on each side of the breast. The teats of the bear amount to four. The sheep has but two placed between the hinder legs. Other animals such as the bitch and the sow have them all along the belly and as they produce many young they have a great many teats for their support. The form also of the teats varies in different animals and in the same animal at different ages. The bosom in females seems to unite all our ideas of beauty where the outline is continually changing and the gradations are soft and regular.

The graceful fall of the shoulders both in man and woman constitute no small part of beauty. In apes though otherwise made like us the shoulders are high and drawn up on each side towards the ears. In man they fall by a gentle declivity and the more so in proportion to the beauty of his form. In fact being high shouldered is not without reason considered as a deformity for we find very sickly persons are always so, and people when dying are ever seen with their shoulders drawn up in a surprising manner. The muscles that serve to raise the ribs mostly rise near the shoulders and the higher we raise the shoulders we the more easily raise the ribs likewise. It happens therefore in the sickly

* Mr Buffon says that none but mokeys have them but this is an oversight

and the dying, who do not breathe without labour, that to raise the ribs, they are obliged to call in the assistance of the shoulders, and thus their bodies assume, from habit, that form which they are so frequently obliged to assume. Women with child also, are usually seen to be high-shouldered, for the weight of the inferior parts drawing down the ribs, they are obliged to use every effort to elevate them, and thus they raise the shoulders of course. During pregnancy, also, the shape, not only of the shoulders, but also of the breast, and even the features of the face, are greatly altered, for the whole upper fore-part of the body is covered with a broad thin skin, called the myoides; which being, at that time, drawn down, it also draws down with it the skin, and, consequently, the features of the face. By these means, the visage takes a particular form; the lower eye-lids and the corners of the mouth, are drawn downwards, so that the eyes are enlarged, and the mouth lengthened and women, in these circumstances, are said by the midwives, to be *all mouth and eyes* ”

The arms of men but very little resemble the fore-feet of quadrupeds, and much less the wings of birds. The ape is the only animal that is possessed of hands and arms; but these are much more rudely fashioned, and with less exact proportion, than in men, “the thumb not being so well opposed to the rest of the fingers, in their hands, as in ours ”

The form of the back is not much different in man from that of other quadruped animals, only that the reins are more muscular in him, and stronger. The buttock, however, in man, is different from that of all other animals whatsoever. What goes by that name in other creatures, is only the upper part of the thigh, man being the only animal that supports himself perfectly erect, the largeness of this part is owing to the peculiarity of his position.

Man's feet, also, are different from those of all other animals, those even of apes not excepted. The foot of the ape is rather a kind of awkward hand, its toes, or rather fingers, are long, and that of the middle longest of all. This foot also wants the heel, as in man, the sole is narrower, and less adapted to maintain the equilibrium of the body, in walking, dancing, or running.

The nails are less in man than in any other animal If they were much longer than the extremities of the fingers they would rather be prejudicial than serviceable and obstruct the management of the hand Such savages as let them grow long make use of them in slaying animals in tearing their flesh and such like purposes however though their nails are considerably larger than ours they are by no means to be compared to the hoofs or the claws of other animals They may sometimes be seen longer indeed than the claws of any animal whatsoever as we learn that the nails of some of the learned men in China are longer than their fingers But these want that solidity which might give force to their exertions and could never in a state of nature have served them for annoyance or defence

There is little known exactly with regard to the proportion of the human figure and the beauty of the best statues is better conceived by observing than by measuring them The statues of antiquity which were at first copied after the human form are now become the models of it nor is there one man found whose person approaches to those inimitable performances that have thus in one figure united the perfections of many It is sufficient to say, that from being at first models they are now become originals and are used to correct the deviations in that form from whence they were taken I will not however pretend to give the proportions of the human body as taken from these there being nothing more arbitrary and which good painters themselves so much condemn Some for instance who have studied after these divide the body into ten times the length of the face and others into eight Some pretend to tell us that there is a similitude of proportion in different parts of the body Thus that the hand is the length of the face the thumb the length of the nose the space between the eyes is the breadth of an eye that the breadth of the thigh at thickest is double that of the thickest part of the leg and treble the smallest that the arms extended are as long as the figure is high that the legs and thighs are half the length of the figure All this however is extremely arbitrary and the excellence of a shape or the beauty of a statue results from the attitude and position of the whole rather than

any established measurements, begun without experience, and adopted by caprice. In general, it may be remarked, that the proportions alter in every age, and are obviously different in the two sexes. In women, the shoulders are narrower, and the neck proportionably longer, than in men. The hips also are considerably larger, and the thighs much shorter than in men. These proportions, however, vary greatly at different ages. In infancy, the upper parts of the body are much larger than the lower; the legs and thighs do not constitute any thing like half the height of the whole figure; in proportion as the child increases in age, the inferior parts are found to lengthen, so that the body is not equally divided until it has acquired its full growth.

The size of men varies considerably. Men are said to be tall who are from five feet eight inches to six feet high. The middle stature is from five feet five to five feet eight, and those are said to be of small stature who fall under these measures. "However, it ought to be remarked, that the same person is always taller when he rises in the morning, than upon going to bed at night, and sometimes there is an inch difference, and I have seen more. Few persons are sensible of this remarkable variation; and I am told, it was first perceived in England by a recruiting officer. He often found that those men whom he had enlisted for soldiers, and answered to the appointed standard at one time, fell short of it when they came to be measured before the colonel at the head-quarters. This diminution in their size proceeded from the different times of the day, and the different states of the body, when they happened to be measured. If, as was said, they were measured in the morning, after the night's refreshment, they were found to be commonly half an inch, and very often a whole inch, taller than if measured after the fatigues of the day, if they were measured when fresh in the country, and before a long fatiguing march to the regiment, they were found to be an inch taller than when they arrived at their journey's end. All this is now well known among those who recruit for the army, and the reason of this difference of stature is obvious. Between all the joints of the back-bone, which is composed of several pieces, there is a glutinous liquor deposited, which serves, like oil in a machine, to give the parts an easy play upon each other. This lubricating liquor, or synovia, as the anatomists call it, is

A lion of repose and is consumed by poured in during the sweat so that in a body after hard exercise and employment of it remaining but all the joints labour there is scarce any motion becomes hard and painful. It grows stiff and their motion the body diminishes in stature is from hence therefore drained away from between the joints. For this moisture being back bone they lie closer upon numerous joints of the whole length is thus very sensibly each other and their weight restoring the fluid again swells diminished but sleep heats and the whole is extended to the spaces between the joints. It is thus often found to differ from its former dimensions.

As the human body is found to differ in its weight also, and itself in size so it is found any apparent cause is found to be the same person without another. If after having eaten a heavier at one time than rank hard the person should find hearty dinner or having could appear no way extraordinary, himself thus heavier it was very often found heavier some but the fact is the body is more than immediately succeed hours after eating a hearty person fatigued by a days hard labour should eat a plentiful supper and then get himself weighed upon going to bed himself considerably heavier than again weighed he will find it is often found to amount to a pound and a half. From whence this adventitious weight is derived is not easy to conceive. At night appears rather plentifully the body during the whole day rather losing than gaining perspiring than imbibing and have no reason to doubt but that ing moisture however weaps by a peculiar set of pores it either by the lungs or per quantity of fluid which thus in is all this time inhaling a whole body upon being weighed creases the weight of the body. The next morning * it is externally more delicate than

Although the human body it is notwithstanding extremely any of the quadruped kind and its size stronger than that of muscular and perhaps could offer to compare the strength any other animal. If we shall we should consider that the of the lion with that of man

* From this experiment also the learned may gather upon what a weak foundation the whole doctrine of Sennetian perspiration is built but this disquisition more properly belongs to medicine than natural history

claws of this animal, give us a false idea of its power; we ascribe to its force what is only the effects of its arms. Those which man has received from Nature are not offensive; happy had Art never furnished him with any more terrible than those which arm the paws of the lion.

But there is another manner* of comparing the strength of man with that of other animals; namely, by the weights which either can carry. We are assured that the porters of Constantinople carry burdens of nine hundred pounds weight. Mr. Desaguliers tells us of a man, who by distributing weights in such a manner as that every part of his body bore its share, he was thus able to raise a weight of two thousand pounds. A horse, which is about seven times our bulk, would be thus able to raise a weight of fourteen thousand pounds, if its strength were in the same proportion † “But the truth is, a horse will not carry upon its back above a weight of two or three hundred pounds; while a man of confessedly inferior strength is thus able to support two thousand. Whence comes this seeming superiority? The answer is obvious. Because the load upon the man’s shoulders is placed to the greatest advantage, while, upon the horse’s back, it is placed at the greatest disadvantage. Let us suppose for a moment the man standing as upright as possible, under the great load above mentioned. It is obvious that all the bones of his body may be compared to a pillar supporting a building, and that his muscles have scarce any share in this dangerous duty. However, they are not entirely inactive, as man, let him stand never so upright, will have some bending in different parts of his body. The muscles, therefore, give the bones some assistance, and that with the greatest possible advantage. In this manner, a man has been found to support two thousand weight, but may be capable of supporting a still greater. The manner in which this is done, is by strapping the load round the shoulders of the person who is to bear it, by a machine, something like that by which milk-vessels or water-buckets are carried. The load being thus placed on a scaffold, on each side, contrived for that purpose, and the man standing erect in the midst, all parts of the scaffold, except that where the man

* Mr Buffon calls it a better manner, but this is not the case

† Mr Buffon carries this subject no farther, and thus far, without explanation, it is erroneous

stands are made to sinl and thus the man maintaining his position the load whatever it is becomes suspended and the column of his bones may be fairly said to support it. If however he should but ever so little give way he must inevitably drop and no power of his can raise the weights again. But the case is very different with regard to a load laid upon a horse. The column of the bones there lies a different way and a weight of five hundred pounds as I am told would break the back of the strongest horse that could be found. The great force of a horse and other quadrupeds is exerted when the load is in such a position as that the column of the bones can be properly applied which is lengthwise. When therefore we are to estimate the comparative strength of a horse we are not to try what he can carry but what he can draw and in this case his amazing superiority over man is easily discerned for one horse can draw a load that ten men cannot move. And in some cases it happens that a draught horse draws the better for being somewhat loaded for as the peasants say the load upon the back keeps him the better to the ground.

There is still another way of estimating human strength by the perseverance and agility of our motions. Men who are exercised in running outstrip horses or at least hold their speed for a longer continuance. In a journey also a man will walk down a horse and after they have both continued to proceed for several days the horse will be quite tired and the man will be fresher than in the beginning. The King's messengers of Ispahan who are runners by profession go thirty six leagues in fourteen hours. Travellers assure us that the Hottentots outstrip lions in the chase and that the savages who hunt the elk pursue with such speed that they at last tire down and take it. We are told many very surprising things of the great swiftness of the savages and of the long journies they undertake on foot through the most craggy mountains where there are no paths to direct nor houses to entertain them. They are said to perform a journey of twelve hundred leagues in less than six weeks. But notwithstanding what travellers report of this matter I have been assured from many of our officers and soldiers who compared their own swiftness with that of the native Americans during the last war that although the savages held out and as the phrase is had but

ter bottoms, yet, for a spurt, the Englishmen were more nimble and speedy ”

Nevertheless, in general, civilized man is ignorant of his own powers: he is ignorant how much he loses by effeminacy; and what might be acquired by habit and exercise. Here and there, indeed, men are found among us of extraordinary strength; but that strength, for want of opportunity, is seldom called into exertion. “ Among the ancients it was a quality of much greater use than at present; as in war the same man that had strength sufficient to carry the heaviest armour, had strength sufficient also to strike the most fatal blow. In this case, his strength was at once his protection and his power. We ought not to be surprised, therefore, when we hear of one man terrible to an army, and irresistible in his career, as we find some generals represented in ancient history. But we may be very certain that this prowess was exaggerated by flattery, and exalted by terror. An age of ignorance is ever an age of wonder. At such times, mankind, having no just ideas of the human powers, are willing rather to represent what they wish, than what they know; and exalt human strength, to fill up the whole sphere of their limited conceptions. Great strength is an accidental thing, two or three in a country may possess it; and these may have a claim to heroism. But what may lead us to doubt of the veracity of these accounts is, that the heroes of antiquity are represented as the sons of heroes, then amazing strength is delivered down from father to son; and this we know to be contrary to the course of nature. Strength is not hereditary, although titles are. and I am very much induced to believe, that this great tribe of heroes, who are all represented as the descendants of heroes, are more obliged to their titles than to their strength, for their characters. With regard to the shining characters in Homer, they are all represented as princes, and as the sons of princes; while we are told of scarce any share of prowess in the meaner men of the army, who are only brought into the field for these to protect, or to slaughter. But nothing can be more unlikely than that those men, who were bred in the luxury of courts, should be strong, while the whole body of the people, who received a plainer and simpler education, should be comparatively weak. Nothing can be more contrary to the general laws of nature, than that all the sons of heroes

should thus inherit not only the kingdoms, but the strength of their forefathers and we may conclude that they owe the greatest share of their imputed strength rather to the dignity of their stations than the force of their arms, and like all fortunate princes their flatterers happened to be believed. In later ages indeed we have some accounts of amazing strength, which we can have no reason to doubt of. But in these nature is found to pursue her ordinary course and we find their strength accidental. We find these strong men among the lowest of the people and gradually rising into notice as this superiority had more opportunity of being seen. Of this number was the Roman tribune who went by the name of the second Achilles who with his own hand is said to have killed at different times three hundred of the enemy and when treacherously set upon by twenty five of his own countrymen although then past his sixtieth year killed fourteen of them before he was slain. Of this number was Milo who when he stood upright could not be forced out of his place. Pliny also tells us of one Athanasius who walked across the stage at Rome loaded with a breastplate weighing five hundred pounds and buskins of the same weight. But of all the prodigies of strength of whom we have any accounts in Roman history Maximian the emperor is to be reckoned the foremost. Whatever we are told relative to him is well attested his character was too exalted not to be thoroughly known and that very strength for which he was celebrated at last procured him no less a reward than the empire of the world. Maximian was above nine feet in height and the best proportioned man in the whole empire. He was by birth a Thracian and from being a simple herdsman rose through the gradations of office until he came to be emperor of Rome. The first opportunity he had of exerting his strength was in the presence of all the citizens in the theatre where he overthrew twelve of the strongest men in wrestling and outstript two of the fleetest horses in running all in one day. He could draw a chariot laden that two strong horses could not move he could break a horse's jaw with a blow of his fist and its thigh with a kick. In war he was always foremost and invincible happy had it been for him and his subjects if from being formidable to his enemies he had not become still more so to his subjects, he reigned for

some time, with all the world his enemy ; all mankind wishing him dead, yet none daring to strike the blow As if fortune had resolved that through life he should continue unconquerable, he was killed at last by his own soldiers while he was sleeping. We have many other instances, in later ages, of very great strength, and not fewer of amazing swiftness ; but these, merely corporeal perfections, are now considered as of small advantage, either in war or in peace. The invention of gunpowder has, in some measure, levelled all force to one standard ; and has wrought a total change in martial education through all parts of the world. In peace also the invention of new machines every day, and the application of the strength of the lower animals to the purposes of life, have rendered human strength less valuable. The boast of corporeal force is, therefore, consigned to savage nations, where those arts not being introduced, it may still be needful ; but, in more polite countries, few will be proud of that strength which other animals can be taught to exert to as useful purposes as they

“ If we compare the largeness and thickness of our muscles with those of any other animal, we shall find that, in this respect, we have the advantage ; and if strength, or swiftness, depended upon the quantity of muscular flesh alone, I believe that, in this respect, we should be more active and powerful than any other. But this is not the case ; a great deal more than the size of the muscles goes to constitute activity or force, and it is not he who has the thickest legs that can make the best use of them. Those, therefore, who have written elaborate treatises on muscular force, and have estimated the strength of animals by the thickness of their muscles, have been employed to very little purpose It is in general observed, that thin and raw-boned men are always stronger and more powerful, than such as are seemingly more muscular, as in the former all the parts have better room for their exertions ”

Women want much of the strength of men ; and, in some countries, the stronger sex have availed themselves of this superiority, in cruelly and tyrannically enslaving those who were made with equal pretensions to a share in all the advantages life can bestow. Savage nations oblige their women to a life of continual labour, upon them rest all the drud-

genes of domestic duty while the husband indolently reclined in his hammock is first served from the fruits of her industry From this negligent situation he is seldom roused except by the calls of appetite when it is necessary either by fishing or hunting to make a variety in his entertainments A savage has no idea of taking pleasure in exercise he is surpris'd to see an European walk forward for his amusement and then return back again As for his part he could be contented to remain for ever in the same situation perfectly satisfied with sensual pleasures and undisturbed repose The women of these countries are the greatest slaves upon earth sensible of their weakness and unable to resist they are obliged to suffer those hardships which are naturally inflicted by such as have been taught that nothing but corporeal force ought to give pre-eminence It is not therefore till after some degree of refinement that women are treated with lenity and not till the highest degree of politeness that they are permitted to share in all the privileges of man The first impulse of savage nature is to confirm their slavery the next of half barbarous nations is to appropriate their beauty and that of the perfectly polite to engage their affections In civilized countries therefore women have united the force of modesty to the power of their natural charms and thus obtain that superiority over the mind which they are unable to extort by their strength

CHAP VI

OF SLEEP AND HUNGER

As man, in all the privileges he enjoys, and the powers he is invested with, has a superiority over all other animals, so, in his necessities, he seems inferior to the meanest of them all. Nature has brought him into life with a greater variety of wants and infirmities than the rest of her creatures, unarmed in the midst of enemies. The lion has natural arms, the bear natural clothing; but man is destitute of all such advantages, and, from the superiority of his mind alone, he is to supply the deficiency. The number of his wants, however, were merely given, in order to multiply the number of his enjoyments, since the possibility of being deprived of any good, teaches him the value of its possession. Were man born with those advantages which he learns to possess by industry, he would very probably enjoy them with a blunter relish, it is by being naked, that he knows the value of a covering, it is by being exposed to the weather, that he learns the comforts of an habitation. Every want thus becomes a means of pleasure, in the redressing, and the animal that has most desires, may be said to be capable of the greatest variety of happiness.

Beside the thousand imaginary wants peculiar to man, there are two, which he has in common with all other animals, and which he feels in a more necessary manner than they. These are the wants of sleep and hunger. Every animal that we are acquainted with, seems to endure the want of these with much less injury to health than man, and some are most surprisingly patient in sustaining both. The little domestic animals that we keep about us, may often set a lesson of calm resignation, in supporting want and watchfulness, to the boasted philosopher. They receive their pittance at uncertain intervals, and wait its coming with cheerful expectation. We have instances of the dog and the cat living in this manner, without food,

for several days and yet still preserving their attachment to the tyrant that oppresses them still ready to exert their little services for his amusement or defence. But the patience of these is nothing to what the animals of the forest endure. As these mostly live upon accidental carnage so they are often known to remain without food for several weeks together. Nature kindly solicitous for their support has also contracted their stomachs to suit them for their precarious way of living and kindly while it abridges the banquet lessons the necessity of providing for it. But the merrier tribes of animals are made still more capable of sustaining life without food many of them remaining in a state of torpid indifference till their prey approaches when they jump upon and seize it. In this manner the snake or the spider continue for several months together to subsist upon a single meal and some of the butterfly kinds live upon little or nothing. But it is very different with man his wants duly make their importunate demands and it is known that he cannot continue to live many days without eating drinking and sleeping.

Hunger is a much more powerful enemy to man than watchfulness and kills him much sooner. It may be considered as a disorder that food removes and that would quickly be fatal without its proper antidote. In fact it is so terrible to man that to avoid it he even encounters certain death and rather than endure its tortures exchanges them for immediate destruction. However by what I have been told it is much more dreadful in its approaches than in its continuance and the pains of a famishing wretch decrease as his strength diminishes. In the beginning the desire of food is dreadful indeed as we know by experience for there are few who have not in some degree felt its approaches. But after the first or second day its tortures become less terrible and a total insensibility at length comes kindly in to the poor wretch's assistance. I have talked with the captain of a ship who was one of six that endured it in its extremities and who was the only person that had not lost his senses when they received accidental relief. He assured me his pains at first were so great as to be often tempted to eat a part of one of the men who died and which the rest of his

crew actually for some time lived upon he said, that during the continuance of this paroxysm, he found his pains insupportable; and was desirous, at one time, of anticipating that death which he thought inevitable: but his pains, he said, gradually decreased, after the sixth day, (for they had water in the ship, which kept them alive so long,) and then he was in a state rather of languor than desire; nor did he much wish for food, except when he saw others eating, and that for a while revived his appetite, though with diminished importunity. The latter part of the time, when his health was almost destroyed, a thousand strange images rose upon his mind; and every one of his senses began to bring him wrong information. The most fragrant perfumes appeared to him to have a foetid smell; and every thing he looked at took a greenish hue, and sometimes a yellow. When he was presented with food by the ship's company that took him and his men up, four of whom died shortly after, he could not help looking upon it with loathing, instead of desire, and it was not till after four days, that his stomach was brought to its natural tone, when the violence of his appetite returned, with a sort of canine eagerness.

Thus dreadful are the effects of hunger, and yet when we come to assign the cause that produces them, we find the subject involved in doubt and intricacy. This longing eagerness is, no doubt, given for a very obvious purpose, that of replenishing the body, wasted by fatigue and perspiration. Were not men stimulated by such a pressing monitor, they might be apt to pursue other amusements, with a perseverance beyond their power; and forget the useful hours of refreshment, in those more tempting ones of pleasure. But hunger makes a demand that will not be refused, and, indeed, the generality of mankind seldom await the call.

Hunger has been supposed by some to arise from the rubbing of the coats of the stomach against each other, without having any intervening substance to prevent their painful attrition. Others have imagined, that its juices, wanting their necessary supply, turn acid, or, as some say, pungent; and thus fret its internal coats, so as to produce a train of the most uneasy sensations. Boerhaave, who established his reputation in physic, by uniting the

conjectures of all those that preceded him ascribes hunger to the united effect of both these causes, and asserts that the pungency of the gastric juices and the attrition of its coats against each other cause those pains which nothing but food can remove. These juices continuing still to be separated in the stomach and every moment becoming more acid mix with the blood and infect the circulation the circulation being thus contaminated becomes weaker and more contracted, and the whole nervous frame sympathizing in hectic fever and sometimes madness is produced in which state the faint wretch expires. In this manner the man who dies of hunger may be said to be poisoned by the juices of his own body, and is destroyed less by the want of nourishment than by the vitiated qualities of that which he had already taken.

However this may be we have but few instances of men dying except at sea of absolute hunger. The decline of those unhappy creatures who are destitute of food it kind being more slow and unperceived. These from often being in need and as often receiving an accidental supply pass their lives between surfeiting and repining and their constitution is impaired by insensible degrees. Man is unfit for a state of precarious expectation. That share of provident precaution which incites him to lay up stores for a distant day becomes his torment when totally unprovided against an immediate call. The lower race of animals when satisfied for the instant moment are perfectly happy but it is otherwise with man his mind anticipates distress and feels the prangs of want even before it arrests him. Thus the mind being continually harassed by the situation it at length influences the constitution and unfits it for all its functions. Some cruel disorder but no way like hunger seizes the unhappy sufferer so that almost all those men who have thus long lived by chance and whose every day may be considered as an happy escape from famine are known at last to die in reality of a disorder caused by hunger but which in the common language is often called a *broken heart*. Some of these I have known myself when very little able to relieve them and I have been told by a very active and worthy magistrate that the number of such as die in London for want is much greater than one

would imagine—I think he talked of two thousand in a year!

But how numerous soever those who die of hunger may be, many times greater, on the other hand, are the number of those who die by repletion. It is not the province of the present page to speculate, with the physician, upon the danger of surfeits; or, with the moralist, upon the nauseousness of gluttony: it will only be proper to observe, that as nothing is so prejudicial to health as hunger by constraint, so nothing is more beneficial to the constitution than voluntary abstinence. It was not without reason that religion enjoined this duty, since it answered the double purpose of restoring the health oppressed by luxury, and diminished the consumption of provisions, so that a part might come to the poor. It should be the business of the legislature, therefore, to enforce this divine precept, and thus, by restraining one part of mankind in the use of their superfluities, to consult for the benefit of those who want the necessaries of life. The injunctions for abstinence are strict over the whole Continent, and where rigorously observed even among ourselves, for a long time after the Reformation. Queen Elizabeth, by giving her commands upon this head the air of a political injunction, lessened, in a great measure, and in my opinion very unwisely, the religious force of the obligation. She enjoined that her subjects should fast from flesh on Fridays and Saturdays; but at the same time declared, that this was not commanded from motives of religion, as if there were any differences in meats, but merely to favour the consumption of fish, and thus to multiply the number of mariners, and also to spare the stock of sheep, which might be more beneficial in another way. In this manner the injunction defeated its own force; and this most salutary law became no longer binding, when it was supposed to come purely from man. How far it may be enjoined in the Scriptures, I will not take upon me to say; but this may be asserted, that if the utmost benefit to the individual, and the most extensive advantage to society, serve to mark any institution as of Heaven, this of abstinence may be reckoned among the foremost.

Were we to give an history of the various benefits that have arisen from this command, and how conducive it has

been to long life the instances would fatigue with their multiplicity. It is surprising to what a great age the primitive Christians of the East, who retired from persecution in the deserts of Arabia continued to live in all the bloom of health and yet all the rigours of abstemious discipline. Their common allowance as we are told for four and twenty hours was twelve ounces of bread and nothing but water. On this simple beverage St Anthony is said to have lived a hundred and five years, James the hermit an hundred and four Arsenius tutor to the emperor Arcadius an hundred and twenty St Epiphanius an hundred and fifteen Simeon an hundred and twelve and Rombald an hundred and twenty. In this manner did these holy temperate men live to an extreme old age kept cheerful by strong hopes and healthful by moderate labour.

Abstinence which is thus voluntary may be much more easily supported than constrained hunger. Man is said to live without food for seven days which is the usual limit assigned him and perhaps in a state of constraint this is the longest time he can survive the want of it. But in cases of voluntary abstinence of sickness or sleeping he has been known to live much longer.

In the records of the Tower there is an account of a Scotchman imprisoned for felony who for the space of six weeks took not the least sustenance being exactly watched during the whole time and for this he received the king's pardon.

When the American Indians undertake long journeys and when consequently a stock of provisions sufficient to support them the whole way would be more than they could carry in order to obviate this inconvenience instead of carrying the necessary quantity they contrive a method of palliating their hunger by swallowing pills made of calcined shells and tobacco. These pills take away all appetite by producing a temporary disorder in the stomach and no doubt the frequent repetition of this wretched expedient must at last be fatal. By these means however they continue several days without eating cheerfully bearing such extremes of fatigue and watching as would quickly destroy men bred up in a greater state of delicacy. For those arts by which we

learn to obviate our necessities, do not fail to unfit us for their accidental encounter

Upon the whole therefore, man is less able to support hunger than any other animal, and he is not better qualified to support a state of watchfulness. Indeed, sleep seems much more necessary to him, than to any other creature. as, when awake, he may be said to exhaust a greater proportion of the nervous fluid, and, consequently to stand in need of an adequate supply. Other animals, when most awake, are but little removed from a state of slumber; their feeble faculties, imprisoned in matter, and rather exerted by impulse than deliberation, require sleep, rather as a cessation from motion, than from thinking. But it is otherwise with man; his ideas, fatigued with their various excursions, demand a cessation, not less than the body, from toil. and he is the only creature that seems to require sleep from double motives; not less for the refreshment of the mental, than of the bodily frame

There are some lower animals, indeed, that seem to spend the greatest part of their lives in sleep, but, properly speaking, the sleep of such may be considered as a kind of death, and their waking, a resurrection. Flies, and insects, are said to be asleep, at a time that all the vital motions have ceased, without respiration, without any circulation of their juices, if cut in pieces, they do not awake, nor does any fluid ooze out at the wound. These may be considered rather as congealed than as sleeping animals, and their rest, during winter, rather as a cessation from life, than a necessary refreshment; but in the higher races of animals, whose blood is not thus congealed, and thawed by heat, these all bear the want of sleep much better than man, and some of them continue a long time without seeming to take any refreshment from it whatsoever

But man is more feeble; he requires its due return; and if it fails to pay the accustomed visit, his whole frame is in a short time thrown into disorder: his appetite ceases, his spirits are dejected, his pulse becomes quicker and harder; and his mind, abridged of its slumbering visions, begins to adopt waking dreams. A thousand strange phantoms arise, which come and go without his will: these, which are transient in the beginning, at last

take firm possession of the mind which yields to their dominion and after a long struggle runs into confirmed madness. In that horrid state the mind may be considered as a city without walls open to every insult and paying homage to every invader every idea that then starts with any force becomes a reality, and the reason over fatigued with its former importunities makes no head against the tyrannical invasion but submits to it from mere imbecility.

But it is happy for mankind that this state of inquietude is seldom driven to an extreme and that there are medicines which seldom fail to give relief. However man finds it more difficult than any other animal to procure sleep and some are obliged to court its approaches for several hours together before they incline to rest. It is in vain that all light is excluded that all sounds are removed that warmth and softness conspire to invite it the restless and busy mind still retains its former activity and Reason that wishes to lay down the reins in spite of herself is obliged to maintain them. In this disagreeable state the mind passes from thought to thought willing to lose the distinctness of perception by increasing the multitude of the images. At last when the approaches of sleep are near every object of the imagination begins to mix with that next it their outlines become in a manner rounder a part of their distinctions fade away and sleep that ensues fashions out a dream from the remainder.

If then it should be asked from what cause this state of repose proceeds or in what manner sleep thus binds us for several hours together? I must fairly confess my ignorance although it is easy to tell what philosophers say upon the subject. Sleep says one of them * consists in a scarcity of spirits by which the orifices or pores of the nerves in the brain through which the spirits used to flow into the nerves being no longer kept open by the frequency of the spirits shut of themselves thus the nerves wanting a new supply of spirits become lax and unfit to convey any impression to the brain. All this however is explaining a very great obscurity by somewhat more obscure leaving therefore those spirits to open and

shut the entrances to the brain, let us be contented with simply enumerating the effects of sleep upon the human constitution

In sleep, the whole nervous frame is relaxed, while the heart and the lungs seem more forcibly exerted. This fuller circulation produces also a swelling of the muscles, as they always find who sleep with ligatures on any part of their body. This increased circulation also, may be considered as a kind of exercise, which is continued through the frame; and by this, the perspiration becomes more copious, although the appetite for food is entirely taken away. Too much sleep dulls the apprehension, weakens the memory, and unfits the body for labour. On the contrary, sleep too much abridged, emaciates the frame, produces melancholy, and consumes the constitution. It requires some care, therefore, to regulate the quantity of sleep, and just to take as much as will completely restore nature, without oppressing it. The poor, as Otway says, sleep little, forced by their situation, to lengthen out their labour to their necessities, they have but a short interval for this pleasing refreshment; and I have ever been of opinion, that bodily labour demands a less quantity of sleep than mental. Labourers and artisans are generally satisfied with about seven hours; but I have known some scholars who usually slept nine, and perceived their faculties no way impaired by over-sleeping.

The famous Philip Barrettiere, who was considered as a prodigy of learning at the age of fourteen, was known to sleep regularly twelve hours in the twenty-four, the extreme activity of his mind, when awake, in some measure called for an adequate alternation of repose. and, I am apt to think, that when students stint themselves in this particular, they lessen the waking powers of the imagination, and weaken its most strenuous exertions. Animals that seldom think, as was said, can very easily dispense with sleep, and of men, such as think least, will, very probably, be satisfied with the smallest share. A life of study, it is well known, unfits the body for receiving this gentle refreshment, the approaches of sleep are driven off by thinking. when, therefore, it comes at last, we should not be too ready to interrupt its continuance.

Sleep, is indeed, to some, a very agreeable period of their

existence and it has been a question in the schools Which was most happy the man who was a beggar by day and a king by night or he who was a beggar by day, and a king by night ? It is given in favour of the nightly monarch by him who first started the question For the dreamer says he gives the full enjoyment of the dignity without its attendant inconveniences while on the other hand the king who supposes himself degraded feels all the misery of his fallen fortune without trying to find the comforts of his humble situation Thus by day both states have their peculiar distresses but by night the exalted beggar is perfectly blessed and the king completely miserable All this however is rather fanciful than just the pleasure dreams can give us seldom reaches to our waking pitch of happiness the mind often in the midst of its highest visionary satisfactions demands of itself whether it does not owe them to a dream and frequently awakes with the reply

But it is seldom except in cases of the highest delight or the most extreme uneasiness that the mind has power thus to disengage itself from the dominion of fancy In the ordinary course of its operations it submits to those numberless fantastic images that succeed each other and which like many of our waking thoughts are generally forgotten Of these however if any by their oddity or their continuance affect us strongly they are then remembered, and there have been some who felt their impressions so strongly as to mistake them for realities and to rank them among the past actions of their lives

There are others upon whom dreams seem to have a very different effect and who without seeming to remember their impressions the next morning have yet shewn by their actions during sleep that they were very powerfully impelled by their dominion We have numberless instances of such persons who while asleep have performed many of the ordinary duties to which they had been accustomed when waking and with a ridiculous industry have completed by night what they failed doing by day We are told in the German Ephemeride of a young student who being enjoined a severe exercise by his tutor went to bed despairing of accomplishing it The next morning awaking to his great surprise he found the

task fairly written out, and finished in his own handwriting.

He was at first, as the account has it, induced to ascribe this strange production to the operations of an infernal agent; but his tutor, willing to examine the affair to the bottom, set him another exercise, still more severe than the former, and took precautions to observe his conduct the whole night. The young gentleman, upon being so severely tasked, felt the same inquietude that he had done on the former occasion; went to bed gloomy and pensive, pondering on the next day's duty, and, after some time, fell asleep. But shortly after, his tutor, who continued to observe him from a place that was concealed, was surprised to see him get up, and very deliberately go to the table; where he took out pen, ink, and paper, drew himself a chair, and sat very methodically to thinking it seems, that his being asleep, only served to strengthen the powers of his imagination; for he very quickly and easily went through the task assigned him; put his chair aside, and then returned to bed to take out the rest of his nap. What credit we are to give to this account, I will not pretend to determine; but this may be said, that the book from whence it was taken, has some good marks of veracity; for it is very learned, and very dull, and is written in a country noted, if not for truth, at least for want of invention.

The ridiculous story of Arlotto is well known, who has had a volume written, containing a narrative of the actions of his life, not one of which was performed while he was awake. He was an Italian Franciscan friar, extremely rigid in his manners, and remarkably devout and learned in his daily conversation. By night, however, and during his sleep, he played a very different character from what he did by day, and was often detected in very atrocious crimes. He was at one time detected in actually attempting a rape, and did not awake till the next morning, when he was surprised to find himself in the hands of justice. His brothers of the convent often watched him while he went very deliberately into the chapel, and there attempted to commit sacrilege. They sometimes permitted him to carry the chalice and the vestments away into his own chamber, and the next morning amused themselves at the poor man's consternation

for what he had done. But of all his sleeping transgressions that was the most ridiculous in which he was called to pray for the soul of a person departed. Arlotto after having devoutly performed his duty retired to a chamber which was shewn him to rest but there he had no sooner fallen asleep than he began to reflect that the dead body had got a ring upon one of the fingers which might be useful to him accordingly with a pious resolution of sterling it he went down undressed as he was into a room full of women and with great composure endeavoured to seize the ring. The consequence was that he was taken before the inquisition for witchcraft and the poor creature had like to have been condemned till his peculiar character accidentally came to be known how ever he was ordered to remain for the rest of life in his own convent and upon no account whatsoever to stir abroad.

What are we to say to such actions as these? or how account for this operation of the mind in dreaming? It should seem that the imagination by day as well as by night is always employed and that often against our wills it intrudes where it is least commanded or desired. While awake and in health this busy principle cannot much delude us it may build castles in the air and rouse a thousand phantoms before us but we have every one of the senses alive to bear testimony to its falsehood. Our eyes shew us that the prospect is not present our hearing and our touch depose against its reality and our taste and smelling are equally vigilant in detecting the imposture. Reason therefore at once gives judgment upon the cause and the vagrant intruder. Imagination is imprisoned or banished from the mind. But in sleep it is otherwise having as much as possible put our senses from their duty having closed the eyes from seeing and the ears taste and smelling from their peculiar functions and having diminished even the touch itself by all the arts of softness the imagination is then left to riot at large and to lead the understanding without an opposer. Every incursive idea then becomes a reality and the mind not having one power that can prove the illusion takes them for truths. As in madness the senses from struggling with the imagination are at length forced to submit so in

sleep, they seem for a while soothed into the like submission : the smallest violence exerted upon any one of them, however, rouses all the rest in their mutual defence ; and the imagination, that had for a while told its thousand falsehoods, is totally driven away, or only permitted to pass under the custody of such as are every moment ready to detect its imposition.

CHAP. VII.

OF SEEING.*

“ HAVING mentioned the senses as correcting the errors of the imagination, and, as forcing it, in some measure, to bring us just information, it will naturally follow, that we should examine the nature of those senses themselves : we shall thus be enabled to see how far they also impose on us, and how far they contribute to correct each other. Let it be observed, however, that in this we are neither giving a treatise of optics or phonics, but a history of our own perceptions : and to those we chiefly confine ourselves ”

The eyes very soon begin to be formed in the human embryo, and in the chicken also Of all the parts which the animal has double, the eyes are produced the soonest, and appear the most prominent It is true, indeed, that in viviparous animals, and particularly in man, they are not so large in proportion, at first, as in the oviparous kinds ; nevertheless, they are more speedily developed, when they begin to appear, than any other parts of the body It is the same with the organ of hearing, the little bones that compose the internal parts of the ear are entirely formed before the other bones, though much larger, have acquired any part of their growth or solidity. Hence it appears, that those parts of the body which are furnished with the greatest quantity of nerves, are the first in forming Thus

* This chapter is taken from Mr Buffon I believe the reader will readily excuse any apology, and, perhaps, may wish that I had taken this liberty much more frequently What I add is marked, as in a former instance, with inverted commas

the brain and the spinal marrow are the first seen begun in the embryo and in general it may be said that wherever the nerves go or send their branches in great numbers there the parts are soonest begun and the most completely finished

If we examine the eyes of a child some hours or even some days after its birth it will be easily discerned that it as yet makes no use of them The humours of the organ not having acquired a sufficient consistence the rays of light strike but confusedly upon the retina or expansion of nerves at the back of the eye It is not till about a month after they are born that children fix them upon objects, for before that time they turn them indiscriminately every where without appearing to be affected by any At six or seven weeks old they plainly discover a choice in the objects of their attention they fix their eyes upon the most brilliant colours and seem peculiarly desirous of turning them towards the light Hitherto however they only seem to fortify the organ for seeing distinctly but they have still many illusions to correct

The first great error in vision is that the eye inverts every object and it in reality appears to the child until the touch has served to undeceive it turned upside down A second error in vision is that every object appears double The same object forms itself distinctly upon each eye and is consequently seen twice This error also can only be corrected by the touch and although in reality every object we see appears inverted and double yet the judgment and habit have so often corrected the sense that we no longer submit to its imposition but see every object in its just position the very instant it appears Were we therefore deprived of feeling our eyes would not only misrepresent the situation but also the number of all things around us

To convince us that we see objects inverted we have only to observe the manner in which images are represented coming through a small hole in a darkened room If such a small hole be made in a dark room so that no light can come in but through it all the objects without will be painted on the wall behind but in an inverted position their heads downwards For as all the rays which pass from the different parts of the object without

cannot enter the hole in the same extent which they had in leaving the object; since, if so, they would require the aperture to be as large as the object; and, as each part, and every point of the object, sends forth the image of itself on every side, and the rays, which form these images, pass from all points of the object as from so many centres, so such only can pass through the small aperture as come in opposite directions. Thus the little aperture becomes a centre for the entire object; through which the rays from the upper parts, as well as from the lower parts of it pass in converging directions; and, consequently, they must cross each other, in the central point, and thus paint the objects behind, upon the wall, in an inverted position.

It is, in like manner, easy to conceive, that we see all objects double, whatever our present sensations may seem to tell us to the contrary. For to convince us of this, we have only to compare the situation of any one object on shutting one eye, and then compare the same situation by shutting the other. If, for instance, we hold up a finger, and shut the right eye, we shall find it hide a certain part of the room; if again reshutting the other eye, we shall find that part of the room visible, and the finger seeming to cover a part of the room that had been visible before. If we open both eyes, however, the part covered will appear to be between the two extremes. But the truth is, we see the object our finger had covered, one image of it to the right, and the other to the left, but, from habit, suppose that we see but one image placed between both; our sense of feeling having corrected the errors of sight. And thus, also, if instead of two eyes we had two hundred, we should, at first, fancy the objects increased in proportion, until one sense had corrected the errors of another.

“The having two eyes might thus be said to be rather an inconvenience than a benefit, since one eye would answer the purposes of sight as well, and be less liable to illusion. But it is otherwise; two eyes greatly contribute, if not to distinct, at least to extensive vision.* When an object is placed at a moderate distance, by the means of both eyes we see a larger share of it than we possibly could

* Leonardo da Vinci

with one the right eye seeing a greater portion of its right side and the left eye of its corresponding side. Thus both eyes in some measure see round the object and it is this that gives it in nature that bold relief or swelling with which they appear and which no painting how exquisite soever can attain to. The painter must be contented with shading on a flat surface, but the eyes in observing nature do not behold the shading only but a part of the figure also that lies behind those very shadings which gives it that swelling which painters so ardently desire but can never fully imitate.

There is another defect which either of the eyes taken singly would have but which is corrected by having the organ double. In either eye there is a point which has no vision whatsoever so that if one of them only is employed in seeing there is a part of the object to which it is always totally blind. This is that part of the optic nerve where its vein and artery run which being insensible that point of the object that is painted there must continue unseen. To be convinced of this we have only to try a very easy experiment. If we take three black patches and stick them upon a white wall about a foot distant from each other each about as high as the eye that is to observe them then retiring six or seven feet back and shutting one eye by trying for some time we shall find that while we distinctly behold the black spots that are to the right and left that which is in the middle remains totally unseen. Or in other words when we bring that part of the eye where the optic artery runs to fall upon the object it will then become invisible. This defect however in either eye is always corrected by both since the part of the object that is unseen by one will be very distinctly perceived by the other.

Beside the former defects we can have no idea of distances from the sight without the help of touch. Naturally every object we see appears to be within our eyes and a child who has as yet made but little use of the sense of feeling must suppose that every thing it sees makes a part of itself. Such objects are only seen more or less bulky as they approach or recede from its eyes so that a fly that is near will appear larger than an ox at a distance. It is experience alone that can rectify this mistake.

and a long acquaintance with the real size of every object, quickly assures us of the distance at which it is seen. The last man in a file of soldiers appears in reality much less, perhaps ten times more diminutive, than the man next to us, however, we do not perceive this difference, but continue to think him of equal stature; for the numbers we have seen thus lessened by distance, and have found, by repeated experience, to be of the natural size when we come closer, instantly correct the sense, and every object is perceived with nearly its natural proportion. But it is otherwise, if we observe objects in such situations as we have not had sufficient experience to correct the errors of the eye, if, for instance, we look at men from the top of a high steeple, they, in that case, appear very much diminished, as we have not had a habit of correcting the sense in that position.

Although a small degree of reflection will serve to convince us of the truth of these positions, it may not be amiss to strengthen them by an authority which cannot be disputed. Mr Cheselden having cured a boy of thirteen for a cataract, who had hitherto been blind, and thus at once having restored him to sight, curiously marked the progress of his mind upon that occasion. This youth, though he had been till then incapable of seeing, yet was not totally blind, but could tell day from night, as persons in his situation always may. He could also, with a strong light, distinguish black from white, and either from the vivid colour of scarlet; however, he saw nothing of the form of bodies, and, without a bright light, not even colours themselves. He was, at first, cured only in one of his eyes, and when he saw for the first time, he was so far from judging of distances, that he supposed his eye touched every object that he saw, in the same manner as his hands might be said to feel them. The objects that were most agreeable to him were such as were of plain surfaces and regular figures, though he could as yet make no judgment whatever of their different forms, nor give a reason why one pleased him more than another. Although he could form some idea of colours during his state of blindness, yet that was not sufficient to direct him at present, and he could scarcely be persuaded that the colours he now saw were the same with those he had formerly conceived such erroneous ideas of.

He delighted most in green but black objects as if giving him an idea of his former blindness he regarded with horror. He had as was said no idea of forms and was unable to distinguish one object from another though never so different. When those things were shown him which he had been formerly familiarized to by his feeling he beheld them with earnestness in order to remember them a second time but as he had too many to recollect at once he forgot the greatest number and for one he could tell after seeing there was a thousand he was totally unacquainted with. He was very much surprised to find that those things and persons he loved best were not the most beautiful to be seen and even testified displeasure in not finding his parents so handsome as he conceived them to be. It was near two months before he could find that a picture resembled a solid body. Till then he only considered it as a flat surface variously shadowed but when he began to perceive that these kind of shadings actually represented human beings he then began to examine by his touch whether they had not the usual qualities of such bodies and was greatly surprised to find what he expected a very unequal surface to be smooth and even. He was then shown a miniature picture of his father which was contained in his mother's watch case and he readily perceived the resemblance but asked with great astonishment, how so large a face could be contained in so small a compass? It seemed as strange to him as if a bushel was contained in a pint vessel. At first he could bear but a very small quantity of light and he saw every object much greater than the life but in proportion as he saw objects that were really large he seemed to think the former were diminished and although he knew the chamber where he was contained in the house yet until he saw the latter he could not be brought to conceive how a house could be larger than a chamber. Before the operation he had no great expectations from the pleasure he should receive from a new sense he was only excited by the hopes of being able to read and write he said for instance that he could have no greater pleasure in walking in the garden with his sight than he had without it for he walked there at his ease and was acquainted with all the walls. He remarked also with great justice that his former blindness gave him

one advantage over the rest of mankind, which was that of being able to walk in the night with confidence and security. But when he began to make use of his new sense, he seemed transported beyond measure. He said, that every new object was a new source of delight, and that his pleasure was so great as to be past expression. About a year after, he was brought to Epsom, where there is a very fine prospect, with which he seemed greatly charmed, and he called the landscape before him a new method of seeing. He was couched in the other eye, a year after the former, and the operation succeeded equally well. When he saw with both eyes, he said that objects appeared to him twice as large as when he saw but with one, however, he did not see them doubled, or, at least, he shewed no marks as if he saw them so. Mr Cheselden mentions instances of many more that were restored to sight in this manner, they all seemed to concur in their perceptions with this youth; and they all seemed particularly embarrassed in learning how to direct their eyes to the objects they wished to observe.

In this manner it is that our feeling corrects the sense of seeing, and that objects which appear of very different sizes at different distances, are all reduced, by experience, to their natural standard. "But not the feeling only, but also the colour and brightness of the object, contributes, in some measure, to assist us in forming an idea of the distance at which it appears.* Those which we see most strongly marked with light and shade, we readily know to be nearer than those on which the colours are more faintly spread, and that, in some measure, take a part of their hue from the air between us and them.—Bright objects also are seen at a greater distance than such as are obscure, and, most probably, for this reason, that being less similar in colour, to the air which interposes, their impressions are less effaced by it, and they continue more distinctly visible. Thus a black and distant object is not seen so far off as a bright and glittering one, and a fire by night is seen much farther off than by day."

The power of seeing objects at a distance is very rarely

* Mr Buffon gives a different theory, for which I must refer the reader to the original. That I have given, I take to be easy and satisfactory enough.

equal in both eyes When this inequality is in any great degree the person so circumstanced then makes use only of one eye shutting that which sees the least and employing the other with all its power And hence proceeds that awkward look which is known by the name of *strabism*

There are many reasons to induce us to think that such as are near sighted see objects larger than other persons and yet the contrary is most certainly true for they see them less Mr Buffon informs us that he himself is short sighted and that his left eye is stronger than his right He has very frequently experienced upon looking at any object such as the letters of a book that they appear less to the weakest eye and that when he places the book so as that the letters appear double the images of the left eye which is strongest are greater than those of the right which is the most feeble He has examined several others who were in similar circumstances and has always found that the best eye saw every object the largest This he ascribes to habit for near sighted people being accustomed to come close to the object and view but a small part of it at a time the habit ensues when the whole of an object is seen and it appears less to them than to others

Infants having their eyes less than those of adults must see objects also smaller in proportion For the image formed on the back of the eye will be large as the eye is capacious and infants having it not so great cannot have so large a picture of the object This may be a reason also why they are unable to see so distinctly or at such distances as persons arrived at maturity

Old men on the contrary see bodies close to them very indistinctly but bodies at a great distance from them with more precision and this may happen from an alteration in the coats or perhaps humours of the eye and not as is supposed from their diminution The cornea for instance may become too rigid to adapt itself and take a proper convexity for seeing minute objects and its very flatness will be sufficient to fit it for distant vision

When we cast our eyes upon an object extremely brilliant or when we fix and detain them too long upon the same object the organ is hurt and fatigued its vision becomes indistinct and the image of the body which has thus too

violently, or too perseveringly employed us, is painted upon every thing we look at, and mixes with every object that occurs. "And this is an obvious consequence of the eye taking in too much light, either immediately, or by reflection. Every body exposed to the light, for a time, drinks in a quantity of its rays, which being brought into darkness, it cannot instantly discharge. Thus the hand, if it be exposed to broad day-light for some time, and then immediately snatched into a dark room, will appear still luminous and it will be some time before it is totally darkened. It is thus with the eye, which, either by an instant gaze at the sun, or a steady continuance upon some less brilliant object, has taken in too much light; its humours are, for a while, unfit for vision, until that be discharged, and room made for rays of a milder nature." How dangerous the looking upon bright and luminous objects is to the sight, may be easily seen, from such as live in countries covered for most part of the year with snow, who become generally blind before their time. Travellers who cross these countries are obliged to wear a crape before their faces, to save their eyes, which would otherwise be rendered totally unserviceable; and it is equally dangerous in the sandy plains of Africa. The reflection of the light is there so strong, that it is impossible to sustain the effect without incurring the danger of losing one's sight entirely. Such persons, therefore, as read or write for any continuance, should choose a moderate light, in order to save their eyes; and although it may seem insufficient at first, the eye will accustom itself to the shade, by degrees, and be less hurt by the want of light than the excess.

"It is, indeed, surprising how far the eye can accommodate itself to darkness, and make the best of a gloomy situation. When first taken from the light, and brought into a dark room, all things disappear; or, if any thing is seen, it is only the remaining radiations that still continue in the eye. But, after a very little time, when these are spent, the eye takes the advantage of the smallest ray that happens to enter; and this alone would, in time, serve for many of the purposes of life. There was a gentleman of great courage and understanding, who was a major under King Charles I., this unfortunate man, sharing in his master's misfortunes, and being forced abroad, ventured at Madrid

to do his king a signal service, but unluckily failed in the attempt. In consequence of this he was instantly ordered to a dark and dismal dungeon into which the light never entered and into which there was no opening but by a hole at the top down which the keeper put his provisions and presently closed it again on the other side. In this manner the unfortunate loyalist continued for some weeks distressed and disconsolate but at last he began to think he saw some little glimmering of light. This internal dawn seemed to increase from time to time so that he could not only discover the parts of his bed and such other large objects but at length he even began to perceive the mice that frequented his cell and saw them as they ran about the floor eating the crumbs of bread that happened to fall. After some months confinement he was at last set free but such was the effect of the darkness upon him that he could not for some days venture to leave his dungeon but was obliged to accustom himself by degrees to the light of the day.

CHAP. VIII

OF HEARING *

As the sense of hearing as well as of sight gives us notice of remote objects so like that it is subject to similar errors being capable of imposing on us upon all occasions where we cannot rectify it by the sense of feeling. We can have from it no distinct intelligence of the distance from whence a sounding body is heard a great noise far off and a small one every near produce the same sensation and unless we receive information from some other sense we can never distinctly tell whether the sound be a great or a small one.

* This chapter is taken from Mr Buffon except where marked by a cried comma

It is not till we have learned, by experience, that the particular sound which is heard, is of a peculiar kind ; then we can judge of the distance from whence we hear it When we know the tone of the bell, we can then judge how far it is from us

Every body that strikes against another produces a sound, which is simple, and but one in bodies which are not elastic, but which is often repeated in such as are If we strike a bell, or a stretched string, for instance, which are both elastic, a single blow produces a sound, which is repeated by the undulations of the sonorous body, and which is multiplied as often as it happens to undulate or vibrate. These undulations each strike their own peculiar blow, but they succeed so fast, one behind the other, that the ear supposes them one continued sound, whereas, in reality, they make many. A person who should, for the first time, hear the toll of the bell, would very probably be able to distinguish these breaks of sound ; and, in fact, we can readily ourselves perceive an intention and premission in the sound

In this manner, sounding bodies are of two kinds ; those unelastic ones, which, being struck, return but a single sound, and those more elastic, returning a succession of sounds, which uniting together, form a tone This tone may be considered as a great number of sounds, all produced one after the other, by the same body, as we find in a bell, or the string of a harpsichord, which continues to sound for some time after it is struck A continuing tone may also be produced from a non-elastic body, by repeating the blow quick and often, as when we beat a drum, or when we draw a bow along the string of a fiddle

Considering the subject in this light, if we should multiply the number of blows, or repeat them at quicker intervals upon the sounding body, as upon the drum, for instance, it is evident that this will have no effect in altering the tone, it will only make it either more even, or more distinct But it is otherwise, if we increase the force of the blow if we strike the body with double weight, this will produce a tone twice as loud as the former. If, for instance, I strike a table with a switch, this will be very

different from the sound produced by striking it with a cudgel. Hence therefore, we may infer, that all bodies give a louder and graver tone not in proportion to the number of times they are struck but in proportion to the force that strikes them. And if this be so those philosophers who make the tone of a sonorous body of a bell or the string of a harpsichord for instance, to depend upon the number only of its vibrations and not the force have mistaken what is only an effect for a cause. A bell or an elastic string can only be considered as a drum beaten and the frequency of the blows can make no alteration whatever in the tone. The largest bells and the longest and thickest strings have the most forceful vibrations and therefore their tones are the most loud and the most grave.

To know the manner in which sounds thus produced become pleasing it must be observed no one continuing tone how loud and swelling soever can give us satisfaction we must have a succession of them and those in the most pleasing proportion. The nature of this proportion may be thus conceived. If we strike a body incapable of vibration with a double force or what amounts to the same thing with a double mass of matter it will produce a sound that will be doubly grave. Music has been said by the ancients to have been first invented from the blows of different hammers on an anvil. Suppose then we strike an anvil with a hammer of one pound weight and again with a hammer of two pounds it is plain that the two pound hammer will produce a sound twice as grave as the former. But if we strike with a two pound hammer and then with a three pound it is evident that the latter will produce a sound one third more grave than the former. If we strike the anvil with a three pound hammer and then with a four pound it will likewise follow that the latter will be a quarter part more grave than the former. Now in the comparing between all those sounds it is obvious that the difference between one and two is more easily perceived than between two and three three and four or any numbers succeeding in the same proportion. The succession of sounds will be therefore pleasing in proportion to the ease with which they may be distinguished. That sound

which is double the former, or, in other words, the octave to the preceding tone, will, of all others, be the most pleasing harmony. The next to that, which is as two to three, or, in other words, the third, will be most agreeable. And thus, universally, those sounds whose difference may be most easily compared, are the most agreeable.

“Musicians, therefore, have contented themselves with seven different proportions of sound, which are called *notes*, and which sufficiently answer all the purposes of pleasure. Not but that they might adopt a greater diversity of proportions, and some have actually done so, but, in these, the differences of the proportion are so imperceptible, that the ear is rather fatigued than pleased in making the distinction. In order, however, to give variety, they have admitted half tones, but in all the countries where music is yet in its infancy, they have rejected such, and they can find music in none but the obvious ones. The Chinese, for instance, have neither flats nor sharps in their music, but the intervals between their other notes, are in the same proportion with ours.

“Many more barbarous nations have their peculiar instruments of music; and, what is remarkable, the proportion between their notes is in all the same as in ours. This is not the place for entering into the nature of these sounds, their effects upon the air, or their consonances with each other. We are not now giving a history of sound, but of human perception.

“All countries are pleased with music; and if they have not skill enough to produce harmony, at least they seem willing to substitute noise. Without all question, noise alone is sufficient to operate powerfully on the spirits, and, if the mind be already predisposed to joy, I have seldom found noise fail of increasing it into rapture. The mind feels a kind of distracted pleasure in such powerful sounds, braces up every nerve, and riots in the excess. But, as in the eye, an immediate gaze upon the sun will disturb the organs, so, in the ear, a loud unexpected noise disorders the whole frame, and sometimes disturbs the sense ever after. The mind must have time to prepare for the expected shock, and to give its organs the proper tension for its arrival.

“Musical sounds, however, seem of a different kind.

Those are generally most pleasing which are most unexpected. It is not from bracing up the nerves, but from the grateful succession of the sounds that these become so charming. There are few how indifferent soever but have at times felt their pleasing impression and perhaps even those who have stood out against the powerful persuasion of sounds only wanted the proper tune or the proper instrument to allure them.

The ancients give us a thousand strange instances of the effects of music upon men and animals. The story of Arion's harp that gathered the dolphins to the ship side is well known and what is remarkable Schottens assures us * that he saw a similar instance of fishes being allured by music. They tell us of diseases that have been cured, unchastity corrected, seditions quelled, passions removed and sometimes excited even to madness. Dr Wallis has endeavoured to account for these surprising effects by ascribing them to the novelty of the art. For my own part I can scarcely hesitate to impute them to the exaggeration of the writers. They are as hyperbolical in the effects of their oratory and yet we well know there is nothing in the orations which they have left us capable of exciting madness or of raising the mind to that ungodly degree of fury which they describe. As they have exaggerated therefore in one instance, we may naturally suppose that they have done the same in the other and indeed from the few remains we have of their music collected by Meibomius one might be apt to suppose there was nothing very powerful in what is lost. Nor does any one of the ancient instruments such as we see them represented in statues appear comparable to our fiddle.

However this be we have many odd accounts not only among them but the moderns of the power of music and it must not be denied but that on some particular occasion musical sounds may have a very powerful effect. I have seen all the horses and cows in a field where there were above a hundred gathered round a person that was blowing a French horn and seeming to testify an awkward kind of satisfaction. Dogs are well known to be very sensible

* Quod oculis meis spectavi Schottii Mag. c. universalis pars II. lib. 1 p. 26

of different tones in music ; and I have sometimes heard them sustain a very ridiculous part in a concert, where their assistance was neither expected nor desired

“ We are told of Henry IV. of Denmark,* that being one day desirous of trying in person whether a musician, who boasted that he could excite men to madness, was not an impostor, he submitted to the operation of his skill • but the consequence was much more terrible than he expected ; for, becoming actually mad, he killed four of his attendants in the midst of his transports A contrary effect of music we have,† in the cure of a madman of Alais, in France, by music This man, who was a dancing-master, after a fever of five days, grew furious, and so ungovernable that his hands were obliged to be tied to his sides • what at first was rage, in a short time was converted into silent melancholy, which no arts could exhilarate, nor no medicines remove In this sullen and dejected state, an old acquaintance accidentally came to inquire after his health ; he found him sitting up in bed, tied, and totally regardless of every external object round him Happening, however, to take up a fiddle that lay in the room, and touching a favourite air, the poor madman instantly seemed to brighten up at the sound ; from a recumbent posture, he began to sit up, and, as the musician continued playing, the patient seemed desirous of dancing to the sound • but he was tied, and incapable of leaving his bed, so that he could only humour the tune with his head, and those parts of his arms which were at liberty Thus the other continued playing, and the dancing-master practised his own art, as far as he was able, for about a quarter of an hour, when suddenly falling into a deep sleep, in which his disorder came to a crisis, he awaked perfectly recovered

“ A thousand other instances might be added, equally true • let it suffice to add one more, which is not true, I mean that of the tarantula. Every person who has been in Italy now well knows, that the bite of this animal, and its being cured by music, is all a deception When strangers come into that part of the country, the country people are ready enough to take money for dancing to the tarantula. A friend of mine had a servant who suffered himself to be

* Olai Magni, l 15 hist. c 28

† Hist de l'Acad 1708. p 22.

bit the wound which was little larger than the puncture of a pin was uneasy for a few hours and then became well without any farther assistance. Some of the country people however still make a tolerable livelihood of the credulity of strangers as the musician finds his account in it not less than the dancer.

Sounds like light are not only extensively diffused but are frequently reflected. The laws of this reflection it is true are not as well understood as those of light all we know is that sound is principally reflected by hard bodies and their being hollow also sometimes increases the reverberation. No art however can make an echo and some who have bestowed great labour and expence upon such a project have only erected shapeless buildings whose silence was a mortifying lecture upon their presumption.

The internal cavity of the ear seems to be fitted up for the purpose of echoing sound with the greatest precision. This part is fashioned out in the temporal bone like a cavern cut into a rock. In this the sound is repeated and articulated and as some anatomists tell us (for we have as yet but very little knowledge on this subject) is beaten against the tympanum or drum of the ear which moves four little bones joined thereto and these move and agitate the internal air which lies on the other side and lastly this air strikes and affects the auditory nerves which carry the sound to the brain.

One of the most common disorders in old age is deafness which probably proceeds from the rigidity of the nerves in the labyrinth of the ear. This disorder also sometimes proceeds from a stoppage of the wax which art may easily remedy. In order to know whether the defect be an internal or an external one let the deaf person put a repeating watch into his mouth and if he hears it strike he may be assured that his disorder proceeds from an external cause and is in some measure curable for there is a passage from the ears into the mouth by what anatomists call the *eustachian tube* and by this passage people often hear sounds when they are utterly without hearing through the larger channel and this also is the reason that we often see persons who listen with great attention hearken with their mouths open in order to catch all the sound at every aperture.

It often happens, that persons hear differently with one ear from the other, and it is generally found that these have what is called, by musicians, *a bad ear*. Mr Buffon, who has made many trials upon persons of this kind, always found that their defect in judging properly of sounds proceeded from the inequality of their ears; and receiving by both, at the same time, unequal sensations, they form an unjust idea. In this manner, as those people hear false, they also, without knowing it, sing false. Those persons also frequently deceive themselves with regard to the side from whence the sound comes, generally supposing the noise to come on the part of the best ear.

Such as are hard of hearing, find the same advantage in the trumpet made for this purpose, that short-sighted persons do from glasses. These trumpets might be easily improved so as to increase sounds, in the same manner that the telescope does objects; however, they could be used to advantage only in a place of solitude and stillness, as the neighbouring sounds would mix with the more distant, and the whole would produce in the ear nothing but tumult and confusion.

Hearing is a much more necessary sense to man than to animals. With these it is only a warning against danger, or an encouragement to mutual assistance. In man, it is the source of most of his pleasure; and without which the rest of his senses would be of little benefit. A man born deaf, must necessarily be dumb, and his whole sphere of knowledge must be bounded only by sensual objects. We have an instance of a young man, who, being born deaf, was restored at the age of twenty-four to perfect hearing. the account is given in the Memoirs of the Academy of Sciences, 1703, page 18.

A young man, of the town of Chartres, between the age of twenty-three and twenty-four, the son of a tradesman, and deaf and dumb from his birth, began to speak all of a sudden, to the great astonishment of the whole town. He gave them to understand, that about three or four months before, he had heard the sound of the bells for the first time, and was greatly surprised at this new and unknown sensation. After some time, a kind of water issued from his left ear, and he then heard perfectly well with both. During these three months, he was sedu-

lously employed in listening without saying a word and accustoming himself to speak softly (so as not to be heard) the words pronounced by others. He laboured hard also in perfecting himself in the pronunciation and in the ideas attached to every sound. At length having supposed himself qualified to break silence he declared that he could now speak although as yet but imperfectly. Soon after some able divines questioned him concerning his ideas of his past state and principally with respect to God his soul the morality or turpitude of actions. The young man however had not driven his solitary speculations into that channel. He had gone to mass indeed with his parents and learned to sign himself with the cross to kneel down and assume all the grimaces of a man that was praying but he did all this without any manner of knowledge of the intention or the cause. he saw others do the like and that was enough for him. he knew nothing even of death and it never entered into his head. he led a life of pure animal instinct entirely taken up with sensible objects and such as were present. he did not seem even to make as many reflections upon these as might reasonably be expected from his improving situation and yet the young man was not in want of understanding but the understanding of a man deprived of all commerce with others is so very confined that the mind is in some measure totally under the control of its immediate sensations.

Notwithstanding it is very possible to communicate ideas to deaf men which they previously wanted and even give them very precise notions of some abstract subjects by means of signs and of letters. A person born deaf may by time and sufficient pains be taught to write and read to speak and by the motions of the lips to understand what is said to him. however it is probable that as most of the motions of speech are made within the mouth by the tongue the knowledge from the motion of the lips is but very confined. nevertheless I have conversed with a gentleman thus taught and in all the commonly occurring questions and the usual salutations he was ready enough merely by attending to the motion of the lips alone. When I ventured to speak for a short continuance he was totally at a loss although he under

stood the subject, when written, extremely well." Persons taught in this manner, were at first considered as prodigies ; but there have been so many instances of success of late, and so many are skilful in the art of instructing in this way, that though still a matter of some curiosity, it ceases to be an object of wonder.

CHAP. IX.

OF SMELLING, FEELING, AND TASTING

AN animal may be said to fill up that sphere which he can reach by his senses ; and is actually large in proportion to the sphere to which its organ extends. By sight, man's enjoyments are diffused into a wide circle ; that of hearing, though less widely diffused, nevertheless extends his powers ; the sense of smelling is more contracted still , and the taste and touch are the most confined of all. Thus man enjoys very distant objects but with one sense only ; more nearly he brings two senses at once to bear upon them ; his sense of smelling assists the other two, at its own distance ; and of such objects, as a man, he may be said to be in perfect possession.

Each sense, however, the more it acts at a distance, the more capable it is of making combinations , and is, consequently, the more improveable. Refined imaginations, and men of strong minds, take more pleasure, therefore, in improving the delights of the distant senses, than in enjoying such as are scarce capable of improvement.

By combining the objects of the extensive senses, all the arts of poetry, painting, and harmony, have been discovered ; but the closer senses, if I may so call them, such as smelling, tasting, and touching, are, in some measure, as simple as they are limited, and admit of little variety. The man of imagination makes a great and an artificial happiness by the pleasure of altering and combining ; the sensualist just stops where he began, and cultivates only those pleasures which he cannot improve. The sensualist is

contented with those enjoyments that are already made to his hand but the man of pleasure is best pleased with growing happiness

Of all the senses perhaps there is not one in which man is more inferior to other animals than in that of smelling. With man it is a sense that acts in a narrow sphere and disgusts almost as frequently as it gives him pleasure. With many other animals it is diffused to a very great extent and never seems to offend them. Dogs not only trace the steps of other animals but also discover them by the scent at a very great distance and while they are thus exquisitely sensible of all smells they seem no way disgusted by any.

But although this sense is in general so very inferior in man it is much stronger in those nations that abstain from animal food than among Europeans. The Bramins of India have a power of smelling as I am informed equal to what it is in most other creatures. They can smell the water which they drink that to us seems quite inodorous and have a word in their language which denotes a country of fine water. We are told also that the negroes of the Antilles by the smell alone can distinguish between the footsteps of a Frenchman and a negro. It is possible therefore that we may dull this organ by our luxurious way of living and sacrifice to the pleasures of taste those which might be received from perfume.

However it is a sense that we can in some measure dispense with and I have known many that wanted it entirely with but very little inconvenience from its loss. In a state of nature it is said to be useful in guiding us to proper nourishment and deterring us from that which is unwholesome but in our present situation such information is but little wanted and indeed but little attended to. In fact the sense of smelling gives us very often false intelligence. Many things that have a disagreeable odour are nevertheless wholesome and pleasant to the taste and such as make eating an art seldom think a meal fit to please the appetite till it begins to offend the nose. On the other hand there are many things that smell most gratefully and yet are noxious or fatal to the constitution. Some physicians think that perfumes in general are unwholesome that they relax the nerves produce head

aches, and even retard digestion. The manchineel apple, which is known to be deadly poison, is possessed of the most grateful odour. Some of those mineral vapours that are often found fatal in the stomach, smell like the sweetest flowers, and continue thus to flatter till they destroy. This sense, therefore, as it should seem, was never meant to direct us in the choice of food, but appears rather as an attendant than a necessary pleasure.

Indeed, if we examine the natives of different countries, or even different natives of the same, we shall find no pleasure in which they differ so widely as that of smelling. Some persons are pleased with the smell of a rose while I have known others that could not abide to have it approach them. The savage nations are highly delighted with the smell of assafoetida, which is to us the most nauseous stink in nature. It would in a manner seem that our delight in perfumes was made by habit, and that a very little industry could bring us totally to invert the perception of odours.

Thus much is certain, that many bodies which at one distance are an agreeable perfume, when nearer are a most ungrateful odour. Musk and ambergris, in small quantities, are considered by most persons as highly fragrant; and yet, when in larger masses, their scent is insufferable. From a mixture of two bodies, each whereof is, of itself, void of all smell, a very powerful smell may be drawn. Thus, by grinding quick-lime with sal-ammoniac, may be produced a very foetid mixture. On the contrary, from a mixture of two bodies, that are separately disagreeable, a very pleasant aromatic odour may be gained. A mixture of aqua-fortis with spirit of wine produces this effect. But not only the alterations of bodies by each other, but the smallest change in us, makes a very great alteration in this sense, and frequently deprives us of it totally. A slight cold often hinders us from smelling; and as often changes the nature of odours. Some persons, from disorder, retain an incurable aversion to those smells which most pleased them before and many have been known to have an antipathy to some animals, whose presence they instantly perceived by the smell. From all this, therefore, the sense of smelling appears to be an uncertain monitor, easily disordered, and not much missed when totally wanting.

A HISTORY OF

The sense most nearly allied to smelling is that of tasting. This some have been willing to consider merely as a nicer kind of touch and have undertaken to account in a very mechanical manner for the difference of savours. Such bodies said they as are pointed happening to be applied to the papillæ of the tongue excite a very powerful sensation and give us the idea of saltiness. Such on the contrary as are of a rounder figure slide smoothly along the papillæ and are perceived to be sweet. In this manner they have with minute labour gone through the variety of imagined forms in bodies and have given them as imaginary effects. All we can precisely determine upon the nature of tastes is that the bodies to be tasted must be either some what moistened or in some measure dissolved by the saliva before they can produce a proper sensation when both the tongue itself and the body to be tasted are extremely dry no taste whatever ensues. The sensation is then changed and the tongue instead of tasting can only be said like any other part of the body to feel the object.

It is for this reason that children have a stronger relish of tastes than those who are more advanced in life. This organ with them from the greater moisture of their bodies is kept in greater perfection and is consequently better adapted to perform its functions. Every person remembers how great a pleasure he found in sweets while a child but his taste growing more obtuse with age he is obliged to use artificial means to excite it. It is then that he is found to cull in the assistance of poignant sauces and strong relishes of salts and aromatics all which the delicacy of his tender organ in childhood was unable to endure. His taste grows callous to the natural relishes and is artificially formed to others more unnatural so that the highest epicure may be said to have the most depraved taste as it is owing to the bluntness of his organ that he is obliged to have recourse to such a variety of expedients to gratify his appetite.

As smells are often rendered agreeable by habit so also tastes may be. Tobacco and coffee so pleasing to many are yet at first very disagreeable to all. It is not without perseverance that we begin to have a relish for them.

we force nature so long, that what was constraint in the beginning, at last becomes inclination.

The grossest, and yet the most useful of all the senses, is that of feeling. We are often seen to survive under the loss of the rest, but of this we can never be totally deprived, but with life. Although this sense is diffused over all parts of the body, yet it most frequently happens that those parts which are most exercised in touching, acquire the greatest degree of accuracy. Thus the fingers, by long habit, become greater masters in the art than any other, even where the sensation is more delicate and fine *. It is from this habit, therefore, and their peculiar formation, and not as is supposed, from their being furnished with a greater quantity of nerves, that the fingers are thus perfectly qualified to judge of forms. Blind men, who are obliged to use them much oftener, have this sense much finer; so that the delicacy of the touch arises rather from the habit of constantly employing the fingers, than from any fancied nervousness in their conformation.

All animals that are furnished with hands† seem to have more understanding than others. Monkeys have so many actions like those of men, that they appear to have similar ideas of the form of bodies. All other creatures, deprived of hands, can have no distinct ideas of the shape of the objects by which they are surrounded, as they want this organ, which serves to examine and measure their forms, their risings, and depressions. A quadruped, probably, conceives as erroneous an idea of any thing near him, as a child would of a rock or a mountain that it beheld at a distance.

It may be for this reason, that we often see them frightened at things with which they ought to be better acquainted. Fishes, whose bodies are covered with scales, and who have no organs for feeling, must be the most stupid of all animals. Serpents, that are likewise destitute, are yet, by winding round several bodies, better capable of judging of their form. All these, however, can have but very imperfect ideas from feeling; and we have already seen, when deprived of this sense, how little the rest of the senses are to be relied on.

The feeling, therefore, is the guardian, the judge, and

* Buffon, vol vi p 80

† Ibid vol vi p 82

the examiner of all the rest of the senses. It establishes their information and detects their errors. All the other senses are altered by time, and contradict their former evidence but the touch still continues the same and though extremely confined in its operations yet it is never found to deceive. The universe to a man who had only used the rest of his senses would be but a scene of illusion every object misrepresented and all its properties unknown. Mr Buffon has imagined a man just newly brought into existence describing the illusion of his first sensations and pointing out the steps by which he arrived at reality. He considers him as just created and awaking amidst the productions of nature and to animate the narrative still more strongly has made his philosophical man a speaker. The reader will no doubt recollect Adam's speech in Milton as being similar. All that I can say to obviate the imputation of plagiarism is that the one treats the subject more as a poet the other more as a philosopher. The philosopher's man describes his first sensations in the following manner *

I well remember that joyful anxious moment when I first became acquainted with my own existence. I was quite ignorant of what I was how I was produced or from whence I came. I opened my eyes what an addition to my surprise! the light of the day the azure vault of heaven the verdure of the earth the crystal of the waters all employed me at once and animated and filled me with inexpressible delight. I at first imagined that all those objects were within me and made a part of myself. Impressed with this idea I turned my eyes to the sun its splendour dazzled and overpowered me. I shut them once more and to my great concern I supposed that during this short interval of darkness I was again returning to nothing.

Afflicted seized with astonishment I pondered a moment on this great change when I heard a variety of unexpected sounds. The whistling of the wind and the melody of the groves formed a concert the soft cadence of which sunk upon my soul. I listened for some time and was persuaded that all this music was within me.

* Buffon vol vi p 88

Quite occupied with this new kind of existence, I had already forgotten the light, which was my first inlet into life, when I once more opened my eyes, and found myself again in possession of my former happiness. The gratification of the two senses at once, was a pleasure too great for utterance.

I turned my eyes upon a thousand various objects, I soon found that I could lose them, and restore them at will; and amused myself more at leisure with a repetition of this new-made power.

I now began to gaze without emotion, and to hearken with tranquillity, when a light breeze, the freshness of which charmed me, wafted its perfumes to my sense of smelling, and gave me such satisfaction as even increased my self-love.

Agitated, roused by the various pleasures of my new existence, I instantly arose, and perceived myself moved along, as if by some unknown and secret power.

I had scarcely proceeded forward, when the novelty of my situation once more rendered me immoveable. My surprise returned; I supposed that every object around me had been in motion. I gave to them that agitation which I produced by changing place, and the whole creation seemed once more in disorder.

I lifted my hand to my head, I touched my forehead; I felt my whole frame. I then supposed that my hand was the principal organ of my existence, all its informations were distinct and perfect, and so superior to the senses I had yet experienced, that I employed myself for some time in repeating its enjoyments, every part of my person I touched, seemed to touch my hand in turn, and gave back sensation for sensation.

I soon found that this faculty was expanded over the whole surface of my body, and I now first began to perceive the limits of my existence, which I had in the beginning supposed spread over all the objects I saw.

Upon casting my eyes upon my body, and surveying my own form, I thought it greater than all the objects that surrounded me. I gazed upon my person with pleasure, I examined the formation of my hand, and all its motions; it seemed to me large or little in proportion as I approached it to my eyes, I brought it very near, and it then hid

almost every other object from my sight I began soon however to find that my sight gave me uncertain information, and resolved to depend upon my feeling for redress

This precaution was of the utmost service I renewed my motions and walked forward with my face turned to wards the heavens I happened to strike lightly against a palm tree and this renewed my surprise I laid my hand on this strange body it seemed replete with new wonders for it did not return me sensation for sensation as my former feelings had done I perceived that there was something external and which did not make a part of my own existence

I now therefore resolved to touch whatever I saw and vainly attempted to touch the sun, I stretched forth my arm and felt only yielding air at every effort I fell from one surprise into another for every object appeared equally near me and it was not till after an infinity of trials that I found some objects farther removed than the rest

Amazed with the illusions and the uncertainty of my state I sat down beneath a tree the most beautiful fruits hung upon it within my reach I stretched forth my hand and they instantly separated from the branch I was proud of being able to grasp a substance without me I held them up and their weight appeared to me like an animated power that endeavoured to draw them to the earth I found a pleasure in conquering their resistance

I held them near my eye I considered their form and beauty their fragrance still more allured me to bring them nearer I approached them to my lips and drank in their odours the perfume invited my sense of tasting and I soon tried a new sense—How new! how exquisite! Hitherto I had tasted only of pleasure but now it was luxury The power of tasting gave me the idea of possession

Flattered with this new acquisition I continued its exercise till an agreeable languor stealing upon my mind I felt all my limbs become heavy and all my desires suspended My sensations were now no longer vivid and distinct but seemed to lose every object and presented only feeble images confusedly marked At that instant I sunk upon the flowery bank and slumber seized me All now seemed once more lost to me It was then as if I

was returning to my former nothing How long my sleep continued, I cannot tell, as I yet had no perception of time. My awaking appeared like a second birth; and I then perceived that I had ceased for a time to exist. This produced a new sensation of fear; and from this interruption in life, I began to conclude that I was not formed to exist for ever.

In this state of doubt and perplexity, I began to harbour new suspicions, and to fear that sleep had robbed me of some of my late powers; when turning on one side, to resolve my doubts, what was my amazement, to behold another being like myself, stretched by my side! New ideas now began to arise, new passions, as yet unperceived, with fears and pleasures, all took possession of my mind, and prompted my curiosity. Love served to complete that happiness which was begun in the individual; and every sense was gratified in all its varieties.

CHAP X

OF OLD AGE AND DEATH *

EVERY thing in nature has its improvement and decay. The human form is no sooner arrived at its state of perfection, than it begins to decline. The alteration is at first insensible; and often several years are elapsed before we find ourselves grown old. The news of this disagreeable change too generally comes from without; and we learn from others that we grow old, before we are willing to believe the report.

When the body has come to its full height, and is extended into its just dimensions, it then also begins to receive an additional bulk, which rather loads than assists it. This is formed from fat, which generally at the age of thirty-five, or forty, covers all the muscles, and interrupts their activity. Every action is then performed with

* This chapter is taken from Mr Buffon except where it is marked by inverted commas

greater labour and the increase of size only serves as a forerunner of decay

The bones also become every day more solid In the embryo they are as soft almost as the muscles of the flesh; but by degrees they harden and acquire their natural vigour but still however the circulation is carried on through them and how hard soever the bones may seem, yet the blood holds its current through them as through all other parts of the body Of this we may be convinced by an experiment which was first accidentally discovered by our ingenious countryman Mr Belcher Perceiving at a friend's house that the bones of hogs which were fed upon madder were red he tried it upon various animals by mixing this root with their usual food and he found that it tintured the bones in all an evident demonstration that the juices of the body had a circulation through the bones He fed some animals alternately upon madder and their common food for some time and he found their bones tintured with alternate layers in conformity to their manner of living From all this he naturally concluded that the blood circulated through the bones as it does through every other part of the body and that how solid soever they seemed yet like the softest parts they were furnished through all their substance with their proper canals Nevertheless these canals are of very different capacities during the different stages of life In infancy they are capacious and the blood flows almost as freely through the bones as through any other part of the body in manhood their size is greatly diminished the vessels are almost imperceptible and the circulation through them is proportionably slow But in the decline of life the blood which flows through the bones no longer contributing to their growth must necessarily serve to increase their hardness The channels that every where run through the human frame may be compared to those pipes that we every where see crusted on the inside by the water for a long continuance running through them Both every day grow less and less by the small rigid particles which are deposited within them Thus as the vessels are by degrees diminished the juices also which were necessary for the circulation through them are diminished in pro

portion ; till at length, in old age, those props of the human frame are not only more solid, but more brittle

The cartilages, or gristles, which may be considered as bones beginning to be formed, grow also more rigid The juices circulating through them, for there is a circulation through all parts of the body, every day contribute to render them harder , so that these substances, which, in youth, are elastic and pliant, in age become hard and bony As these cartilages are generally placed near the joints, the motion of the joints also must, of consequence, become more difficult Thus, in old age, every action of the body is performed with labour , and the cartilages, formerly so supple, will now sooner break than bend

“ As the cartilages acquire hardness, and unfit the joints for motion, so also that mucous liquor, which is always separated between the joints, and which serves, like oil to a hinge, to give them an easy and ready play, is now grown more scanty. It becomes thicker, and more clammy, more unfit for answering the purposes of motion , and from thence, in old age, every joint is not only stiff, but awkward At every motion this clammy liquor is heard to crack , and it is not without the greatest effort of the muscles that its resistance is overcome. I have seen an old person, who never moved a single joint, that did not thus give notice of the violence done to it ”

The membranes that cover the bones, the joints, and the rest of the body, become, as we grow old, more dense and more dry Those which surround the bones, soon cease to be ductile The fibres, of which the muscles or flesh is composed, become every day more rigid ; and while to the touch the body seems, as we advance in years, to grow softer, it is, in reality, increasing in hardness It is the skin, and not the flesh, that we feel upon such occasions The fat, and the flabbiness of that, seems to give an appearance of softness, which the flesh itself is very far from having There are few can doubt this, after trying the difference between the flesh of young and old animals The first is soft and tender, the last is hard and dry

The skin is the only part of the body that age does not contribute to harden That stretches to every degree of tension ; and we have horrid instances of its pliancy, in many disorders incident to humanity In youth, therefore, while

the body is vigorous and increasing it still gives way to its growth. But although it thus adapts itself to our increase it does not in the same manner conform to our decay. The skin which in youth was filled and glossy when the body begins to decline has not elasticity enough to shrink entirely with its diminution. It hangs therefore in wrinkles which no art can remove. The wrinkles of the body in general proceed from this cause. But those of the face seem to proceed from another namely from the many varieties of positions into which it is put by the speech the food or the passions. Every grimace and every passion wrinkles up the visage into different forms. These are visible enough in young persons but what at first was accidental or transitory becomes unalterably fixed in the visage as it grows older.

From hence we may conclude that a freedom from passions not only adds to the happiness of the mind but preserves the beauty of the face and the person that has not felt their influence is less strongly marked by the decays of nature.

Hence therefore as we advance in age the bones the cartilages the membranes the flesh the skin and every fibre of the body become more solid more brittle and more dry. Every part shrinks every motion becomes more slow the circulation of the fluids is performed with less freedom perspiration diminishes the secretions alter the digestion becomes slow and laborious and the juices no longer serving to convey their accustomed nourishment those parts may be said to live no longer when the circulation ceases. Thus the body dies by little and little all its functions are diminished by degrees life is driven from one part of the frame to another universal rigidity prevails and death at last seizes upon the little that is left.

As the bones the cartilages the muscles and all other parts of the body are softer in women than in men these parts must of consequence require a longer time to come to that hardness which hastens death. Women therefore ought to be a longer time in growing old than men and this is actually the case. If we consult the tables which have been drawn up respecting human life we shall find that after a certain age they are more long lived than men all other circumstances the same. A woman of sixty has a better chance than a man of the same age to live till eighty. Upon

the whole, we may infer, that such persons as have been slow in coming up to maturity, will also be slow in growing old, and this holds as well with regard to other animals as to man

The whole duration of the life of either vegetables or animals, may be, in some measure, determined from their manner of coming to maturity. The tree, or the animal, which takes but a short time to increase to its utmost pitch, perishes much sooner than such as are less premature. In both the increase upwards is first accomplished, and not till they have acquired their greatest degree of height do they begin to spread in bulk. Man grows in stature till about the age of seventeen, but his body is not completely developed till about thirty. Dogs, on the other hand, are at their utmost size in a year, and become as bulky as they usually are in another. However, man, who is so long in growing, continues to live fourscore, or a hundred years, but the dog seldom above twelve or thirteen. In general, also, it may be said, that large animals live longer than little ones, as they usually take a longer time to grow. But in all animals, one thing is equally certain, that they carry the cause of their own decay about them, and that their deaths are necessary and inevitable. The prospects which some visionaries have formed of perpetuating life by remedies, have been often enough proved false by their own example. Such unaccountable schemes would, therefore, have died with them, had not the love of life always augmented our credulity.

When the body is naturally well formed, it is possible to lengthen out the period of life for some years by management. Temperance in diet is often found conducive to this end. The famous Cornaro, who lived to above a hundred years, although his constitution was naturally feeble, is a strong instance of the benefit of an abstemious life. Moderation in the passions also may contribute to extend the term of our existence. "Fontenelle, the celebrated writer, was naturally of a very weak and delicate habit of body. He was affected by the smallest irregularities, and had frequently suffered severe fits of illness from the slightest causes. But the remarkable equality of his temper, and his seeming want of passion, lengthened out his life to above an hundred. It was remarkable of him, that nothing could vex or make him uneasy, every occurrence seemed equally pleasing, and no

even, however unfortunate seemed to come unexpected." However the term of life can be prolonged but for a very little time by any art we can use. We are told of men who have lived beyond the ordinary duration of human existence, such as Parr who lived to a hundred and forty four, and Jenkins to a hundred and sixty five. yet these men used no peculiar arts to prolong life. on the contrary it appears that these as well as others remarkable for their longevity, were persons accustomed to the greatest fatigues who had no settled rules of diet but who often indulged in accidental excesses. Indeed if we consider that the European the Negro the Chinese and the American the civilized man and the savage the rich and the poor the inhabitant of the city and of the country though all so different in other respects are yet entirely similar in the period allotted them for living if we consider that neither the difference of race of climate of nourishment of convenience or of soil makes any difference in the term of life if we consider that those men who live upon raw flesh or dried fishes upon sago or rice upon cassava or upon roots nevertheless live as long as those who are fed upon bread and meat we shall readily be brought to acknowledge that the duration of life depends neither upon habit customs or the quantity of food we shall confess that nothing can change the laws of that mechanism which regulates the number of our years and which can chiefly be affected only by long fasting or great excess.

If there be any difference in the different periods of man's existence it ought principally to be ascribed to the quality of the air. It has been observed that in elevated situations there have been found more old people than in those that were low. The mountains of Scotland Wales Auvergne and Switzerland have furnished more instances of extreme old age than the plains of Holland Flanders Germany or Poland. But in general the duration of life is nearly the same in most countries. Man if not cut off by accidental diseases is often found to live to ninety or a hundred years. Our ancestors did not live beyond that date and since the times of David this term has undergone little alteration.

If we be asked how in the beginning men lived so much longer than at present and by what means their lives were extended to nine hundred and thirty or even nine hundred and sixty years it may be answered that the productions of

the earth, upon which they fed, might be of a different nature at that time from what they are at present “It may be answered, that the term was abridged by Divine command, in order to keep the earth from being overstocked with human inhabitants ; since, if every person were now to live and generate for nine hundred years, mankind would be increased to such a degree, that there would be no room for subsistence : so that the plan of Providence would be altered ; which is seen not to produce life without providing a proper supply.”

But to whatever extent life may be prolonged, or however some may have delayed the effects of age, death is the certain goal to which all are hastening All the causes of decay which have been mentioned contribute to bring on this dreaded dissolution. However, nature approaches to this awful period by slow and imperceptible degrees, life is consumed day after day, and some one of our faculties, or vital principles, is every hour dying before the rest, so that death is only the last shade in the picture, and it is probable that man suffers a greater change in going from youth to age, than from age into the grave When we first begin to live, our lives may scarcely be said to be our own, as the child grows, life increases in the same proportion, and is at its height in the prime of manhood But as soon as the body begins to decrease, life decreases also, for as the human frame diminishes, and its juices circulate in smaller quantity, life diminishes and circulates with less vigour ; so that as we begin to live by degrees, we begin to die in the same manner.

Why then should we fear death, if our lives have been such as not to make eternity dreadful ? Why should we fear that moment, which is prepared by a thousand other moments of the same kind ? the first pangs of sickness being probably greater than the last struggles of departure Death, in most persons, is as calmly endured as the disorder that brings it on If we inquire from those whose business it is to attend the sick and the dying, we shall find that, except in a very few acute cases, where the patient dies in agonies, the greatest number die quietly, and seemingly without pain : and even the agonies of the former rather terrify the spectators than torment the patient, for how many have we not seen who have been accidentally relieved from this extremity,

and yet had no memory of what they then endured ? In fact they had ceased to live during that time when they ceased to have sensation, and their pains were only those of which they had an idea.

The greatest number of mankind die therefore without sensation and of those few that still preserve their faculties entire to the last moment there is scarcely one of them that does not also preserve the hopes of still outliving his disorder. Nature for the happiness of man has rendered this sentiment stronger than his reason. A person dying of an incurable disorder which he must know to be so by frequent examples of his case which he perceives to be so by the inquietude of all around him by the tears of his friends and the departure or the face of the physician is nevertheless still in hopes of getting over it. His interest is so great, that he only attends to his own representations the judgment of others is considered as a hasty conclusion and while death every moment makes new inroads upon his constitution and destroys life in some part hope still seems to escape the universal ruin and is the last that submits to the blow.

Cast your eyes upon a sick man who has a hundred times told you that he felt himself dying that he was convinced he could not recover and that he was ready to expire examine what passes on his visage when through zeal or in discretion any one comes to tell him that his end is at hand. You will see him change like one who is told an unexpected piece of news. He now appears not to have thoroughly believed what he had been telling you himself he doubted much and his fears were greater than his hopes but he still had some feeble expectations of living and would not have seen the approaches of death unless he had been alarmed by the mistaken assiduity of his attendants.

Death therefore is not that terrible thing which we suppose it to be. It is a spectre which frights us at a distance but which disappears when we come to approach it more closely. Our ideas of its terrors are conceived in prejudice and dressed up by fancy we regard it not only as the greatest misfortune but as also an evil accompanied with the most excruciating tortures we have even increased our apprehensions, by reasoning on the extent of our suffering.

“ It must be dreadful, ’ say some, “ since it is sufficient to separate the soul from the body • it must be long, since our sufferings are proportioned to the succession of our ideas ; and these being painful, must succeed each other with extreme rapidity ” In this manner has false philosophy laboured to augment the miseries of our nature, and to aggravate that period which Nature has kindly covered with insensibility Neither the mind nor the body can suffer these calamities the mind is, at that time, mostly without ideas, and the body too much enfeebled to be capable of perceiving its pain A very acute pain produces either death or fainting, which is a state similar to death the body can suffer but to a certain degree, if the torture become excessive, it destroys itself ; and the mind ceases to perceive, when the body can no longer endure

In this manner, excessive pain admits of no reflection : and wherever there are any signs of it, we may be sure that the sufferings of the patient are no greater than what we ourselves may have remembered to endure

But, in the article of death, we have many instances in which the dying person has shewn that very reflection which presupposes an absence of the greatest pain, and, consequently, that pang which ends life cannot even be so great as those which have preceded Thus, when Charles XII. was shot at the siege of Frederickshall, he was seen to clap his hand on the hilt of his sword, and although the blow was great enough to terminate one of the boldest and bravest lives in the world, yet it was not painful enough to destroy reflection He perceived himself attacked, he reflected that he ought to defend himself, and his body obeyed the impulse of his mind, even in the last extremity Thus it is the prejudice of persons in health, and not the body in pain, that makes us suffer from the approach of death, we have all our lives contracted a habit of making out excessive pleasures and pains, and nothing but repeated experience shews us how seldom the one can be suffered, or the other enjoyed to the utmost

If there be any thing necessary to confirm what we have said concerning the gradual cessation of life, or the insensible approaches of our end, nothing can more effectually prove it than the uncertainty of the signs of death. If we consult

what Winslow or Brulier have said upon this subject we shall be convinced that between life and death the shade is so very undistinguishable that even all the powers of art can scarcely determine where the one ends and the other begins. The colour of the visage the warmth of the body the suppleness of the joints are but uncertain signs of life still subsisting while on the contrary the paleness of the complexion the coldness of the body the stiffness of the extremities the cessation of all motion and the total insensibility of the parts are but uncertain marks of death begun. In the same manner also with regard to the pulse and the breathing these motions are often so kept under that it is impossible to perceive them. By approaching a looking glass to the mouth of the person supposed to be dead people often expect to find whether he breathes or not. But this is a very uncertain experiment the glass is frequently sullied by the vapour of the dead man's body and often the person is still alive although the glass is no way tarnished. In the same manner neither burning nor scarifying neither noises in the ears nor pungent spirits applied to the nostrils give certain signs of the discontinuance of life and there are many instances of persons who have endured them all and afterwards recovered without any external assistance to the astonishment of the spectators. How careful therefore, should we be before we commit those who are dearest to us to the grave to be well assured of their departure experience justice humanity all persuade us not to hasten the funerals of our friends but to keep their bodies unburied until we have certain signs of their real decease.

CHAP. XI.

OF THE VARIETIES IN THE HUMAN RACE

HITHERTO we have compared man with other animals, we now come to compare men with each other. We have hitherto considered him as an individual, endowed with excellencies above the rest of the creation; we now come to consider the advantages which men have over men, and the various kinds with which our earth is inhabited.

If we compare the minute differences of mankind, there is scarce one nation upon the earth that entirely resembles another, and there may be said to be as many different kinds of men as there are countries inhabited. One polished nation does not differ more from another, than the merest savages do from those savages that lie even contiguous to them, and it frequently happens that a river, or a mountain, divides two barbarous tribes that are unlike each other in manners, customs, features, and complexion. But these differences, however perceivable, do not form such distinctions as come within a general picture of the varieties of mankind. Custom, accident, or fashion, may produce considerable alterations in neighbouring nations, their being derived from ancestors of a different climate, or complexion, may contribute to make accidental distinctions, which every day grow less, and it may be said, that two neighbouring nations, how unlike soever at first, will assimilate by degrees, and by long continuance, the difference between them will at last become almost imperceptible. It is not, therefore, between contiguous nations we are to look for any strong marked varieties in the human species: it is by comparing the inhabitants of opposite climates and distant countries; those who live within the polar circles, with those beneath the equator, those that live on one side of the globe, with those that occupy the other.

Of all animals, the differences between mankind are the smallest. Of the lower races of creatures, the changes are so great as often entirely to disguise the natural animal, and to distort, or to disfigure, its shape. But the chief

differences in man are rather taken from the tincture of his skin than the variety of his figure as in all climates he preserves his erect deportment and the marked superiority of his form. If we look round the world there seem to be not above six* distinct varieties in the human species each of which is strongly marked and speaks the kind seldom to have mixed with any other. But there is nothing in the shape nothing in the faculties that shows their coming from different originals and the varieties of climate of nourishment and custom are sufficient to produce every change.

The first distinct race of men is found round the polar regions. The Laplanders the Esquimaux Indians the Samoid Tartars the inhabitants of Nova Zembla the Borandians the Greenlanders and the natives of Kamtschatka may be considered as one peculiar race of people all greatly resembling each other in their stature their complexion their customs and their ignorance. These nations being under a rigorous climate where the productions of nature are but few and the provisions coarse and unwholesome their bodies have shrunk to the nature of their food and their complexions have suffered from cold almost a similar change to what heat is known to produce their colour being a deep brown in some places inclining to actual blackness. These therefore in general are found to be a race of short stature and odd shape with countenances as savage as their manners are barbarous. The visage in these countries is large and broad the nose flat and short the eyes of a yellowish brown inclining to blackness the eyelids drawn towards the temples the cheek bones extremely high the mouth very large the lips thick and turned outwards the voice thin and squeaking the head large the hair black and strait the colour of the skin of a dark grayish †. They are short in stature the generality not being above four feet high and the tallest not above five. Among all these nations the women are as deformed as the men and resemble them so nearly that one cannot at first distinguish the sexes among them.

* I have taken four of these varieties from Linnaeus those of the Laplanders and Tartars from Mr Buffon

† Krantz

These nations not only resemble each other in their deformity, their dwarfishness, the colour of their hair and eyes, but they have, in a great measure, the same inclinations, and the same manners, being all equally rude, superstitious, and stupid. The Danish Laplanders have a large black cat, to which they communicate their secrets, and consult in all their affairs. Among the Swedish Laplanders there is in every family a drum for consulting the devil; and although these nations are robust and nimble, yet they are so cowardly that they never can be brought into the field. Gustavus Adolphus attempted to form a regiment of Laplanders, but he found it impossible to accomplish his design; for it should seem that they can live only in their own country, and in their own manner. They make use of skates, which are made of fir, of near three feet long, and half a foot broad; these are pointed, and raised before, and tied to the foot by straps of leather. With these they skate on the icy snow, and with such velocity, that they very easily overtake the swiftest animals. They make use also of a pole, pointed with iron at one end, and rounded at the other. This pole serves to push them along, to direct their course, to support them from falling, to stop the impetuosity of their motion, and to kill that game which they have overtaken. Upon these skates they descend the steepest mountains, and scale the most craggy precipices; and, in these exercises, the women are not less skilful than the men. They have all the use of the bow and arrow, which seems to be a contrivance common to all barbarous nations; and which, however, at first, required no small skill to invent. They launch a javelin, also, with great force, and some say, that they can hit a mark, no larger than a crown, at thirty yards distance, and with such force as would pierce a man through. They are all hunters, and particularly pursue the ermine, the fox, the ounce, and the martin, for the sake of their skins. These they barter, with their southern neighbours, for brandy and tobacco; both which they are fond of to excess. Their food is principally dried fish, the flesh of rein-deer and bears. Their bread is composed of the bones of fishes, pounded and mixed with the inside tender bark of the pine-tree. Their drink is train oil or brandy, and, when deprived of these, water, in which juniper berries

have been infused With regard to their morals they have all the virtues of simplicity and all the vices of ignorance They offer their wives and daughters to strangers and seem to think it a particular honour if their offer be accepted They have no idea of religion or a Supreme Being the greatest number of them are idolaters and their superstition is as profound as their worship is contemptible Wretched and ignorant as they are yet they do not want pride they set themselves far above the rest of mankind and Krantz assures us that when the Greenlanders are got together nothing is so customary among them as to turn the Europeans into ridicule They are obliged indeed to yield them the pre eminence in understanding and mechanic arts but they do not know how to set any value upon these They therefore count themselves the only civilized and well bred people in the world and it is common with them when they see a quiet or a modest stranger to say that he is almost as well bred as a Greenland

From this description therefore this whole race of people may be considered as distinct from any other — Their long continuance in a climate the most inhospitable their being obliged to subsist on food the most coarse and ill prepared the savageness of their manners and their laborious lives all have contributed to shorten their stature and to deform their bodies * In proportion as we approach towards the north pole the size of the natives appears to diminish growing less and less as we advance higher till we come to those latitudes that are destitute of all inhabitants whatsoever

The wretched natives of these climates seem fitted by nature to endure the rigours of their situation As their food is but scanty and precarious their patience in hunger is amazing † A man who has eaten nothing for four days can manage his little canoe in the most furious waves and calmly subsist in the midst of a tempest that would quickly dash an European boat to pieces Their strength is not less amazing than their patience a woman among them will carry a piece of timber or a stone near double the weight of what an European can lift Their

* Ellis's Voyage 1. 2. 6

† Krantz p. 134 vol. 1

bodies are of a dark grey all over; and their faces brown, or olive. The tincture of their skins partly seems to arise from their dirty manner of living, being generally daubed with train-oil; and partly from the rigours of climate, as the sudden alterations of cold and raw air in winter, and of burning heats in summer, shade their complexions by degrees, till, in a succession of generations, they at last become almost black. As the countries in which these reside are the most barren, so the natives seem the most barbarous of any part of the earth. Their more southern neighbours of America, treat them with the same scorn that a polished nation would treat a savage one; and we may readily judge of the rudeness of those manners, which even a native of Canada can think more barbarous than his own.

But the gradations of nature are imperceptible; and, while the north is peopled with such miserable inhabitants, there are here and there to be found, upon the edges of these regions, people of a larger stature, and completer figure. A whole race of the dwarfish breed is often found to come down from the north, and settle more to the southward; and, on the contrary, it sometimes happens that southern nations are seen higher up, in the midst of these diminutive tribes, where they have continued for time immemorial. Thus the Ostiack Tartars seem to be a race that have travelled down from the north, and to be originally sprung from the minute savages we have been describing. There are also Norwegians and Finlanders, of proper stature who are seen to inhabit in latitudes higher even than Lapland. These, however, are but accidental migrations, and serve as shades to unite the distinct varieties of mankind.

The second great variety in the human species, seems to be that of the Tartar race, from whence, probably, the little men we have been describing originally proceeded. The Tartar country, taken in general, comprehends the greatest part of Asia, and is, consequently, a general name given to a number of nations, of various forms and complexions. But, however they seem to differ from each other, they all agree in being very unlike the people of any other country. All these nations have the upper part of the visage very broad, and wrinkled even

while yet in their youth Their noses are short and flat their eyes little and sunk in their heads and in some of them they are seen five or six inches asunder Their cheek bones are high the lower part of their visage narrow the chin long and advanced forward their teeth of an enormous size and growing separate from each other their eyebrows thick large and covering their eyes their eyelids thick the face broad and flat the complexion olive coloured and the hair black They are of a middle size extremely strong and very robust They have but little beard which grows straggling on the chin They have large thighs and short legs The ugliest of all are the Calmucks in whose appearance there seems to be something frightful They all lead an erratic life remaining under tents of hair or skins They live upon horse flesh and that of camels either raw or a little sodden between the horse and the saddle They eat also fish dried in the sun Their most usual drink is mares milk fermented with millet ground into meal They all have the head shaven except a lock of hair on the top which they let grow sufficiently long to form into tresses on each side of the face The women who are as ugly as the men wear their hair, which they bind up with bits of copper and other ornaments of a like nature The majority of these nations have no religion no settled notions of morality no decency of behaviour They are chiefly robbers and the natives of Dagestan who live near their more polished neighbours make a traffic of Tartar slaves who have been stolen and sell them to the Turks and the Persians Their chief riches consist in horses of which perhaps there are more in Tartary than in any other part of the world The natives are taught by custom to live in the same place with their horses they are continually employed in managing them and at last bring them to such great obedience that the horse seems actually to understand the rider's intention

To this race of men also we must refer the Chinese and the Japanese however different they seem in their manners and ceremonies It is the form of the body that we are now principally considering and there is between these countries a surprising resemblance It is in general allowed that the Chinese have broad faces small eyes flat noses and scarce any beard that they are broad

and square shouldered, and rather less in stature than Europeans. These are marks common to them and the Taitais, and they may, therefore, be considered as being derived from the same original. "I have observed," says Chardin, "that in all the people from the east and the north of the Caspian sea, to the peninsula of Malacca, that the lines of the face, and the formation of the visage, is the same. This has induced me to believe, that all these nations are derived from the same original, however different either their complexions or their manners may appear: for as to the complexion, that proceeds entirely from the climate and the food, and as to the manners, these are generally the result of their different degrees of wealth or power." That they come from one stock, is evident also from this, that the Tartars who settle in China, quickly resemble the Chinese, and, on the contrary, the Chinese who settle in Tartary soon assume the figure and the manners of the Tartars.

The Japanese so much resemble the Chinese, that one cannot hesitate to rank them in the same class. They only differ in being rather browner, as they inhabit a more southern climate. They are, in general, described as of a brown complexion, a short stature, a broad flat face, a very little beard, and black hair. Their customs and ceremonies are nearly the same; their ideas of beauty similar; and their artificial deformities of blackening the teeth, and bandaging the feet, entirely alike in both countries. They both, therefore, proceed from the same stock; and although they differ very much from their brutal progenitors, yet they owe their civilization wholly to the mildness of the climate in which they reside, and to the peculiar fertility of the soil. To this tribe, also, we may refer the Cochinchinese, the Siamese, the Tonquinese, and the inhabitants of Arracan, Laos, and Pegu, who, though all differing from the Chinese and each other, nevertheless have too strong a resemblance not to betray their common original.

Another, which makes the third variety in the human species, is, that of the southern Asiatics, the form of whose features and persons may be easily distinguished from those of the Tartar races. The nations that inhabit the peninsula of India, seem to be the principal stock from whence the

inhabitants of the islands that lie scattered in the Indian ocean have been peopled. They are in general of a slender shape with long straight black hair, and often with Roman noses. Thus they resemble the Europeans in stature and features, but greatly differ in colour and habit of body. The Indians are of an olive colour and in the more southern parts quite black although the word Mogul in their language signifies a white man. The women are extremely delicate and bathe very often they are of an olive colour as well as the men their legs and thighs are long and their bodies short which is the opposite to what is seen among the women of Europe. They are as I am assured by no means so fruitful as the European women but they feel the pains of child birth with much less sensibility and are generally up and well the day following. In fact these pains seem greatest in all countries where the women are most delicate or the constitution enfeebled by luxury or indolence. The women of savage nations seem in a great measure exempt from painful labours and even the hard working wives of the peasants among ourselves have this advantage from a life of industry that their child bearing is less painful. Over all India the children arrive sooner at maturity than with us of Europe. They often marry and consummate the husband at ten years old and the wife at eight and they frequently have children at that age. However the women who are mothers so soon cease bearing before they are arrived at thirty and at that time they appear wrinkled and seem marked with all the deformities of age. The Indians have long been remarkable for their cowardice and effeminacy every conqueror that has attempted the invasion of their country having succeeded. The warmth of the climate entirely influences their manners they are slothful submissive and luxurious satisfied with sensual happiness alone they find no pleasure in thinking and contented with slavery they are ready to obey any master. Many tribes among them eat nothing that has life they are fearful of killing the meanest insect and have even erected hospitals for the maintenance of all kinds of vermin. The Asiatic dress is a loose flowing garment rather fitted for the purposes of peace and indolence than of industry or war. The vigour of the Asiatics is in ge

neral, conformable to their dress and nourishment, fed upon rice, and clothed in effeminate silk vestments, their soldiers are unable to oppose the onset of an European army; and from the times of Alexander to the present day, we have scarcely any instances of their success in arms. Upon the whole, therefore, they may be considered as a feeble race of sensualists, too dull to find rapture in any pleasures, and too indolent to turn their gravity into wisdom. To this class we may refer the Persians, and Arabians, and, in general, the inhabitants of the islands that he scattered in the Indian ocean.

The fourth striking variety in the human species, is to be found among the negroes of Africa. This gloomy race of mankind is found to blacken all the southern parts of Africa, from eighteen degrees north of the line, to its extreme termination at the Cape of Good Hope. I know it is said, that the Caffies, who inhabit the southern extremity of that large continent, are not to be ranked among the negro race. however, the difference between them, in point of colour and features, is so small, that they may very easily be grouped in this general picture, and in the one or two that I have seen, I could not perceive the smallest difference. Each of the negro nations, it must be owned, differ from each other; they have their peculiar countries for beauty, like us, and different nations, as in Europe, pride themselves upon the regularity of their features. Those of Guinea, for instance, are extremely ugly, and have an insupportable scent, those of Mosambique are reckoned beautiful, and have no ill smell whatsoever. The negroes, in general, are of a black colour, with a smooth soft skin. This smoothness proceeds from the downy softness of the hair which grows upon it, the strength of which give a roughness to the feel, in those of a white complexion. Their skins, therefore, have a velvet smoothness, and seem less biaced upon the muscles than ours. The hair of their heads differs entirely from what we are accustomed to, being soft, woolly, and short. The beard also partakes of the same qualities, but in this it differs, that it soon turns gray, which the hair is seldom found to do; so that several are seen with white beards, and black hair, at the same time. Their eyes are generally of a deep hazel; their noses flat and short, their lips

thick and tumid and their teeth of an ivory whiteness. Thus their only beauty however is set off by the colour of their skin the contrast between the black and white being the more observable. It is false to say that their features are deformed by art since in the negro children born in European countries the same deformities are seen to prevail the same flatness in the nose and the same prominence in the lips. They are in general said to be well shaped but of such as I have seen I never found one that might be justly called so their legs being mostly ill formed and commonly bending outward on the shin bone. But it is not only in those parts of their bodies that are obvious that they are disproportioned those parts which among us are usually concealed by dress with them are large and ungainly. The women's breasts after bearing one child hang down below the navel and it is customary with them to suckle the child at their backs by throwing the breasts over the shoulder. As their persons are thus naturally deformed at least to our imaginations their minds are equally incapable of strong exertions. The climate seems to relax their mental powers still more than those of the body they are therefore in general found to be stupid indolent and mischievous. The Arabians themselves many colonies of whom have migrated southward into the most inland parts of Africa seem to have degenerated from their ancestors forgetting their ancient learning and losing their beauty they have become a race scarcely any way distinguishable from the original natives. Nor does it seem to have fared otherwise with the Portuguese who about two centuries ago settled along this coast. They also are become almost as black as the negroes and are said by some to be even more barbarous.

The inhabitants of America make a fifth race as different from all the rest in colour as they are distinct in habitation. The natives of America (except in the northern extremity where they resemble the Laplanders) are of a red or copper

Interius in prima linea sua faminis Africae depigit sicut alius videtur in parte gentium testantes quod si nuncupat Attamen non differunt a nostris in hac parte nisi paulisper et non aliquid quantum tum dora. In hominibus tamen penset longum et multo laxior

colour ; and although, in the old world, different climates produce a variety of complexions and customs, the natives of the new continent seem to resemble each other in almost every respect. They are all nearly of one colour ; all have black thick straight hair, and thin black beards ; which, however, they take care to pluck out by the roots. They have, in general, flat noses, with high cheek-bones, and small eyes ; and these deformities of nature they endeavour to increase by art : they flatten the nose, and often the whole head of their children, while the bones are yet susceptible of every impression. They paint the body and face of various colours, and consider the hair upon any part of it, except the head, as a deformity which they are careful to eradicate. Their limbs are generally slighter made than those of the Europeans ; and, I am assured, they are far from being so strong. All these savages seem to be cowardly ; they seldom are known to face their enemies in the field, but fall upon them at an advantage, and the greatness of their fears serves to increase the rigours of their cruelty. The wants which they often sustain, make them surprisingly patient in adversity : distress, by being grown familiar, becomes less terrible ; so that their patience is less the result of fortitude than of custom. They have all a serious air, although they seldom think ; and, however cruel to their enemies, are kind and just to each other. In short, the customs of savage nations in every country are almost the same ; a wild, independent, and precarious life, produces a peculiar train of virtues and vices. and patience and hospitality, indolence and rapacity, content and sincerity, are found not less among the natives of America, than all the barbarous nations of the globe :

The sixth and last variety of the human species, is that of the Europeans, and the nations bordering on them. In this class we may reckon the Georgians, Circassians, and Mingrelians, the inhabitants of Asia Minor, and the northern parts of Africa, together with a part of those countries which lie north-west of the Caspian sea. The inhabitants of these countries differ a good deal from each other, but they generally agree in the colour of their bodies, the beauty of their complexions, the largeness of their limbs, and the vigour of their understandings. Those arts which might have had their invention among the other races of mankind, have

come to perfection there. In barbarous countries the inhabitants go either naked or are awkwardly clothed in furs or feathers in countries semi barbarous the robes are loose and flowing but here the clothing is less made for show than expedition and unites, as much as possible the extremes of ornament and dispatch.

To one or other of these classes we may refer the people of every country and as each nation has been less visited by strangers or has had less commerce with the rest of mankind we find their persons and their manners more strongly impressed with one or other of the characters mentioned above. On the contrary in those places where trade has long flourished or where enemies have made many incursions the races are usually found blended and properly fall beneath no one character. Thus in the islands of the Indian ocean where a trade has been carried on for time immemorial the inhabitants appear to be a mixture of all the nations upon the earth white olive brown and black men are all seen living together in the same city and propagate a mixed breed that can be referred to none of the classes into which naturalists have thought proper to divide mankind.

Of all the colours by which mankind is diversified it is easy to perceive that ours is not only the most beautiful to the eye but the most advantageous. The fair complexion seems if I may so express it as a transparent covering to the soul all the variations of the passions every expression of joy or sorrow flows to the cheek and without language marks the mind. In the slightest change of health also the colour of the European face is the most exact index and often teaches us to prevent those disorders that we do not as yet perceive not but that the African black and the Asiatic olive complexions admit of their alterations also but these are neither so distinct nor so visible as with us and in some countries the colour of the visage is never found to change but the face continues in the same settled shade in shame and in sickness in anger and despair.

The colour therefore most natural to man ought to be that which is most becoming and it is found that in all regions the children are born fair or at least red and that they grow more black or tawny as they advance in age.

It should seem, consequently, that man is naturally white ; since the same causes that darken the complexion in infants, may have originally operated, in slower degrees, in blackening whole nations. We could, therefore, readily account for the blackness of different nations, did we not see the Americans, who live under the line, as well as the natives of Negroland, of a red colour, and but a very small shade darker than the natives of the northern latitudes, in the same continent. For this reason, some have sought for other causes of blackness than the climate ; and have endeavoured to prove that the blacks are a race of people bred from one man, who was marked with accidental blackness. This, however, is but mere ungrounded conjecture : and, although the Americans are not so dark as the negroes, yet we must still continue in the ancient opinion, that the deepness of the colour proceeds from the excessive heat of the climate. For, if we compare the heats of Africa with those of America, we shall find they bear no proportion to each other. In America, all that part of the continent, which lies under the line, is cool and pleasant, either shaded by mountains, or refreshed by breezes from the sea. But in Africa, the wide tract of country that lies under the line is very extensive, and the soil sandy ; the reflection of the sun, therefore, from so large a surface of earth, is almost intolerable ; and it is not to be wondered at, that the inhabitants should bear, in their looks, the marks of the inhospitable climate. In America, the country is but thinly inhabited ; and the more torrid tracts are generally left desert by the inhabitants ; for which reason they are not so deeply tinged by the beams of the sun. But in Africa the whole face of the country is fully peopled ; and the natives are obliged to endure their situation, without a power of migration. It is there, consequently, that they are in a manner tied down to feel all the severity of the heat ; and their complexions take the darkest hue they are capable of receiving. We need not, therefore, have recourse to any imaginary propagation, from persons accidentally black, since the climate is a cause obvious and sufficient to produce the effect.

In fact, if we examine the complexion of different countries, we shall find them darken in proportion to the heat of their climate ; and the shades gradually to deepen as

they approach the line. Some nations indeed may be found not so much tinged by the sun as others although they lie nearer the line. But this ever proceeds from some accidental causes either from the country lying higher and consequently being colder, or from the natives bathing oftener and leading a more civilized life. In general it may be asserted that as we approach the line we find the inhabitants of each country grow browner, until the colour deepens into perfect blackness. Thus taking our standard from the whitest race of people and beginning with our own country which I believe bids fairest for the pre-eminence we shall find the French who are more southern a slight shade deeper than we going farther down the Spaniards are browner than the French the inhabitants of Fez darker than they and the natives of Negroland the darkest of all. In what manner the sun produces this effect and how the same luminary which whitens wax and linen should darken the human complexion is not easy to conceive. Sir Thomas Brown first supposed that a mucous substance which had something of a vitriolic quality settled under the reticular membrane and grew darker with heat. Others have supposed that the blackness lay in the epidermis or scarf skin which was burnt up like leather. But nothing has been satisfactorily discovered upon the subject it is sufficient that we are assured of the fact and that we have no doubt of the sun's tinging the complexion in proportion to its vicinity.

But we are not to suppose that the sun is the only cause of darkening the skin the wind extreme cold hard labour or coarse and sparing nourishment are all found to contribute to this effect. We find the peasants of every country who are most exposed to the weather a shade darker than the higher ranks of people. The savage inhabitants of all places are exposed still more and therefore contract a still deeper hue and this will account for the tawny colour of the North American Indians. Although they live in a climate the same or even more northerly than ours yet they are found to be of complexions very different from those of Europe. But it must be considered that they live continually exposed to the sun that they use many methods to darken their skins by art painting them with red ochre and anointing

them with the fat of bears. Had they taken, for a succession of several generations, the same precautions to brighten their colour that an European does, it is very probable that they would in time come to have similar complexions, and, perhaps, dispute the prize of beauty.

The extremity of cold is not less productive of a tawny complexion than that of heat. The natives of the arctic circle, as was observed, are all brown; and those that lie most to the north are almost entirely black. In this manner both extremes are unfavourable to the human form and colour, and the same effects are produced under the poles that are found at the line.

With regard to the stature of different countries, that seems chiefly to result from the nature of the food, and the quantity of the supply. Not but that the severity of heat or cold, may, in some measure, diminish the growth, and produce a dwarfishness of make. But, in general, the food is the great agent in producing this effect, where that is supplied in large quantities, and where its quality is wholesome and nutrimental, the inhabitants are generally seen above the ordinary stature. On the contrary, where it is afforded in a sparing quantity, or very coarse, and void of nourishment in its kind, the inhabitants degenerate, and sink below the ordinary size of mankind. In this respect they resemble other animals, whose bodies, by proper feeding, may be greatly augmented. An ox, on the fertile plains of India, grows to a size four times as large as the diminutive animal of the same kind bred in the Alps. The horses bred in the plains are larger than those of the mountain. So it is with man, the inhabitants of the valley are usually found taller than those of the hill: the natives of the Highlands of Scotland, for instance, are short, broad, and hardy, those of the Lowlands are tall and shapely. The inhabitants of Greenland, who live upon dried fish and seals, are less than those of Gambia, or Senegal, where Nature supplies them with vegetable and animal abundance.

The form of the face seems rather to be the result of custom. Nations who have long considered some artificial deformity as beautiful, who have industriously lessened the feet, or flattened the nose, by degrees begin to receive the impression they are taught to assume; and Nature,

in a course of ages shapes itself to the constraint, and assumes hereditary deformity. We find nothing more common in births than for children to inherit sometimes even the accidental deformities of their parents. We have many instances of squinting in the father which he received from fright or habit communicated to the offspring, and I myself have seen a child distinctly marked with a scar similar to one the father had received in battle. In this manner accidental deformities may become natural ones and by assiduity may be continued and even increased, through successive generations. From this therefore may have arisen the small eyes and long ears of the Tartar and Chinese nations. From hence originally may have come the flat noses of the blacks and the flat heads of the American Indians.

In this slight survey therefore I think we may see that all the variations in the human figure as far as they differ from our own are produced either by the rigour of the climate the bad quality or the scantiness of the provisions or by the savage customs of the country. They are actual marks of the degeneracy in the human form, and we may consider the European figure and colour as standards to which to refer all other varieties and with which to compare them. In proportion as the Tartar or American approaches nearer to European beauty, we consider the race as less degenerated in proportion as he differs more widely he has made greater deviations from his original form.

That we have all sprung from one common parent we are taught both by reason and religion to believe and we have good reason also to think that the Europeans resemble him more than any of the rest of his children. However it must not be concealed that the olive coloured Asiatic and even the jet black negro claim this honour of hereditary resemblance and assert that white men are mere deviations from original perfection. Odd as this opinion may seem they have Linnæus the celebrated naturalist, on their side who supposes man a native of the tropical climates and only a sojourner more to the north. But, not to enter into a controversy upon a matter of a very remote speculation I think one argument alone will suffice to prove the contrary and shew that the white man is the original

source from whence the other varieties have sprung We have frequently seen white children produced from black parents, but have never seen a black offspring the production of two whites From hence we may conclude, that whiteness is the colour to which mankind naturally tends for, as in the tulip, the parent stock is known by all the artificial varieties breaking into it; so in man, that colour must be original which never alters, and to which all the rest are accidentally seen to change I have seen in London, at different times, two white negroes, the issue of black parents, that served to convince me of the truth of this theory I had before been taught to believe that the whiteness of the negro's skin was a disease, a kind of milky whiteness, that might be called rather a leprous crust than a natural complexion. I was taught to suppose, that the numberless white negroes found in various parts of Africa, the white men that go by the name of Chacrelas, in the East Indies, and the white Americans, near the Isthmus of Darien, in the West Indies, were all as so many diseased persons, and even more deformed than the blackest of the natives But, upon examining that negro which was last shewn in London, I found the colour to be exactly like that of an European; the visage white and ruddy, and the lips of the proper redness. However, there were sufficient marks to convince me of its descent The hair was white and woolly, and very unlike any thing I had seen before The iris of the eye was yellow, inclining to red; the nose was flat, exactly resembling that of a negro, and the lips thick and prominent No doubt, therefore, remained of the child's having been born of negro parents and the person who shewed it had attestations to convince the most incredulous From this, then, we see that the variations of the negro colour is into whiteness, whereas the white are never found to have a race of negro children Upon the whole, therefore, all those changes which the African, the Asiatic, or the American, undergo, are but accidental deformities, which a kinder climate, better nourishment, or more civilized manners, would, in a course of centuries, very probably remove

CHAP. XII

OF MONSTERS

HITHERTO I have only spoken of those varieties in the human species that are common to whole nations but there are varieties of another kind which are only found in the individual and being more rarely seen are therefore called *monstrous*. If we examine into the varieties of distorted nature there is scarcely a limb of the body or a feature in the face that has not suffered some reprobation either from art or nature being enlarged or diminished lengthened or wrested from its due proportion. Linnæus after having given a catalogue of monsters particularly adds the flat heads of Canada the long heads of the Chinese and the slender waists of the women of Europe who by strait lacing take such pains to destroy their health through a mistaken desire to improve their beauty *. It belongs more to the physician than the naturalist to attend to these minute deformities and indeed it is a melancholy contemplation to speculate upon a catalogue of calamities inflicted by un pity ing Nature or brought upon us by our own caprice. Some however are fond of such accounts and there have been books filled with nothing else. To these therefore I refer the reader who may be better pleased with accounts of men with two heads or without any head of children joined in the middle of bones turned into flesh or flesh converted into bones than I am †. It is sufficient here to observe that every day's experience must have shewn us miserable instances of this kind produced by nature or affection calamities that no pity can soften or assiduity relieve

* Linnæ Syst. vol. 1. p. 99. Monorchides ut minus fert l. s.

† V. d. Phil. Trans. passim. Miscell. 1. Curios. Joh. Baptist. We. h. D. assertat. Physica an ex v. r. l. s. l. u. m. n. i. seminis cum brutal. p. r. nef. rium co. tum. commixtione aut vic. ssim. ex. h. uti. m. r. s. cum. n. bebr. l. humano semin. s. comm. xtione possit verus homo generari. V. de eti. m.

Passing over, therefore, every other account, I shall only mention the famous instance quoted by Father Malbranche, upon which he founds his beautiful theory of monstrous productions. A woman of Paris, the wife of a tradesman, went to see a criminal broke alive upon the wheel, at the place of public execution. She was at that time two months advanced in her pregnancy, and no way subject to any disorders to affect the child in her womb. She was, however, of a tender habit of body; and, though led by curiosity to this horrid spectacle, very easily moved to pity and compassion. She felt, therefore, all those strong emotions which so terrible a sight must naturally inspire; shuddered at every blow the criminal received, and almost swooned at his cries. Upon returning from this scene of blood, she continued for some days pensive, and her imagination still wrought upon the spectacle she had lately seen. After some time, however, she seemed perfectly recovered from her fright, and had almost forgotten her former uneasiness. When the time of her delivery approached, she seemed no ways mindful of her former terrors, nor were her pains in labour more than usual in such circumstances. But what was the amazement of her friends and assistants when the child came into the world! It was found that every limb in its body was broken like those of the malefactor, and just in the same place. This poor infant, that had suffered the pains of life even before its coming into the world, did not die, but lived in an hospital in Paris, for twenty years after, a wretched instance of the supposed powers of imagination in the mother, of altering and distorting the infant in the womb. The manner in which Malbranche reasons upon this fact, is as follows: the Creator has established such a sympathy between the several parts of nature, that we are led not

Johnstoni *Thaumatographia Naturalis* Vide Adalberti *Disquisitio Physica* ostentat duorum puerorum unus quorum dente aureo, alter cum capite giganteo Biluæ spectabantur. A man without lungs and stomach, *Journal de Scavans*, 1682, p 301, another without any brain, *Andreas Caroli Memorabilia*, p 167, an 1676, another without any head, *Giornale di Roma*, anno 1675, p 26, another without any arms, *New Memoirs of Literature*, vol iv p 446. In short, the variety of these accounts is almost infinite, and, perhaps, their use is as much circumscribed as their variety is extensive.

only to imitate each other but also to partake in the same affections and desires. The animal spirits are thus carried to the respective parts of the body to perform the same actions which we see others perform to receive in some measure their wounds and take part in their sufferings. Experience tells us that if we look attentively on any person severely beaten or sorely wounded the spirits immediately flow into those parts of the body which correspond to those we see in pain. The more delicate the constitution the more it is thus affected the spirits making a stronger impression on the fibres of a weakly habit than of a robust one. Strong vigorous men see an execution without much concern while women of nicer texture are struck with horror and concern. This sensibility in them must of consequence be communicated to all parts of their body and as the fibres of the child in the womb are incomparably finer than those of the mother the course of the animal spirits must consequently produce greater alterations. Hence every stroke given to the criminal forcibly struck the imagination of the woman and by a kind of counter stroke the delicate tender frame of the child.

Such is the reasoning of an ingenious man upon a fact the veracity of which many have since called in question.* They have allowed indeed that such a child might have been produced but have denied the cause of its deformity.

How could the imagination of the mother say they produce such dreadful effects upon her child? She has no communication with the infant she scarcely touches it in any part quite unaffected with her concerns it sleeps in security in a manner secluded by a fluid in which it swims from her that bears it. With what a variety of deformities say they would all mankind be marked if all the vain and capricious desires of the mother were thus readily written upon the body of the child! Yet, notwithstanding this plausible way of reasoning I cannot avoid giving some credit to the variety of instances I have either read or seen upon this subject. If it be a prejudice it is as old as the days of Aristotle and to this day as strongly believed by the generality of mankind as ever.

It does not admit of a reason; and, indeed, I can give none, even why the child should, in any respect, resemble the father or the mother. The fact we generally find to be so. But why it should take the particular print of the father's features in the womb is as hard to conceive, as why it should be effected by the mother's imagination. We all know what a strong effect the imagination has on those parts in particular, without being able to assign a cause how this effect is produced; and why the imagination may not produce the same effect in marking the child that it does in forming it, I see no reason. Those persons whose employment it is to rear up pigeons of different colours can breed them, as their expression is, to a feather. In fact, by properly pairing them, they can give what colour they will to any feather, in any part of the body—Were we to reason upon this fact, what could we say? Might it not be asserted, that the egg, being distinct from the body of the female, cannot be influenced by it? Might it not be plausibly said, that there is no similitude between any part of the egg and any particular feather which we expect to propagate; and yet, for all this, the fact is known to be true, and what no speculation can invalidate. In the same manner, a thousand various instances assure us, that the child in the womb is sometimes marked by the strong affections of the mother. how this is performed we know not; we only see the effect, without any connection between it and the cause. The best physicians have allowed it; and have been satisfied to submit to the experience of a number of ages, but many disbelieve it, because they expect a reason for every effect. This, however, is very hard to be given, while it is very easy to appear wise by pretending incredulity.

Among the number of monsters, dwarfs, and giants, are usually reckoned, though not, perhaps, with the strictest propriety, since they are no way different from the rest of mankind, except in stature. It is a dispute, however, about words, and therefore scarcely worth contending about. But there is a dispute, of a more curious nature, on this subject; namely, whether there are races of people thus very diminutive, or vastly large; or whether they be merely accidental varieties, that now and then are seen in a country, in a few

persons, whose bodies some external cause has contributed to lessen or enlarge

With regard to men of diminutive stature all antiquity has been unanimous in asserting their national existence. Homer was the first who has given us an account of the pigmy nation contending with the cranes, and what poetical licence might be supposed to exaggerate. Athenæus has attempted seriously to confirm by historical assertion *. If we attend to these we must believe that in the internal parts of Africa there are whole nations of pigmy beings not more than a foot in stature who continually wage an unequal war with the birds and beasts that inhabit the plains in which they reside. Some of the ancients however and Strabo in particular have supposed all these accounts to be fabulous and have been more inclined to think this supposed nation of pigmies nothing more than a species of apes well known to be numerous in that part of the world. With this opinion the moderns have all concurred and that diminutive race which was described as human has been long degraded into a class of animals that resemble us but very imperfectly.

The existence therefore of a pigmy race of mankind being founded in error or in fable we can expect to find men of diminutive stature only by accident among men of the ordinary size. Of these accidental dwarfs every country and almost every village can produce numerous instances. There was a time when these unfavoured children of Nature were the peculiar favourites of the great and no prince or noblemen thought himself completely attended unless he had a dwarf among the number of his domestics. These poor little men were kept to be laughed at or to raise the barbarous pleasure of their masters by their contrasted inferiority. Even in England as late as the times of King James I the court was at one time furnished with a dwarf a giant and a jester these the king often took a pleasure in opposing to each other and often fomented quarrels among them in order to be a concealed spectator of their animosity. It was a particular entertainment of the courtiers at that time to see little Jeffrey for so the dwarf was called, ride round the lists expecting his antagonist

* Athenæus ix 390

and discovering, in his actions, all the marks of contemptible resolution.

It was in the same spirit, that Peter of Russia, in the year 1710, celebrated a marriage of dwarfs. This monarch, though raised by his native genius far above a barbarian, was, nevertheless, still many degrees removed from actual refinement. His pleasures, therefore, were of the vulgar kind; and this was among the number. Upon a certain day, which he had ordered to be proclaimed several months before, he invited the whole body of his courtiers, and all the foreign ambassadors, to be present at the marriage of a pigmy man and woman. The preparations for this wedding were not only very grand, but executed in a style of barbarous ridicule. He ordered that all the dwarf men and women, within two hundred miles, should repair to the capital, and also insisted that they should be present at the ceremony. For this purpose he supplied them with proper vehicles, but so contrived it, that one horse was seen carrying in a dozen of them into the city at once, while the mob followed, shouting and laughing, from behind. Some of them were at first unwilling to obey an order which they knew was calculated to turn them into ridicule, and did not come; but he soon obliged them to obey; and, as a punishment, enjoined, that they should wait upon the rest at dinner. The whole company of dwarfs amounted to seventy, besides the bride and bridegroom, who were richly adorned, and in the extremity of the fashion. For this little company in miniature, every thing was suitably provided; a low table, small plates, little glasses, and, in short, every thing was so fitted as if all things had been dwindled to their own standard. It was his great pleasure to see their gravity and their pride, the contention of the women for places, and the men for superiority. This point he attempted to adjust, by ordering that the most diminutive should take the lead, but this bred disputes, for none would then consent to sit foremost. All this, however, being at last settled, dancing followed the dinner, and the ball was opened with a minuet by the bridegroom, who measured exactly three feet two inches high. In the end, matters were so contrived, that this little company, who met together in gloomy pride, and unwilling to be pleased, being at last familiarized to laughter, joined in the diversion, and

became, as the journalist has it * extremely sprightly and entertaining

But whatever may be the entertainment such guests might afford when united I never found a dwarf capable of affording any when alone I have sometimes conversed with some of these that were exhibited at our fairs about Town, and have ever found their intellects as contracted as their persons They in general seemed to me to have faculties very much resembling those of children and their desires likewise of the same kind being diverted with the same sports and best pleased with such companions Of all those I have seen which may amount to five or six the little man whose name was Coan that died lately at Chelsea was the most intelligent and sprightly I have heard him and the giant who sung at the theatres sustain a very ridiculous duet to which they were taught to give great spirit But this mirth and seeming gravity were but assumed He had by long habit been taught to look cheerful upon the approach of company and his conversation was but the mere etiquette of a person that had been used to receive visitors When driven out of his walk nothing could be more stupid or ignorant nothing more dejected or forlorn But we have a complete history of a dwarf very accurately related by Mr Daubenton in his part of the *Histoire Naturelle* which I will here take leave to translate

This dwarf whose name was Baby was well known having spent the greatest part of his life at Lunenville in the palace of Stanislaus the titular king of Poland He was born near the village of Plaisne in France in the year 1741 His father and mother were peasants both of good constitutions and inured to a life of husbandry and labour Baby when born weighed but a pound and a quarter We are not informed of the dimensions of his body at that time but we may conjecture they were very small as he was presented on a plate to be baptized and for a long time lay in a slipper His mouth although proportioned to the rest of his body was not at that time, large enough to take in the nipple and he was

* De dench wurd ge fwerig Hockweit &c Lpsix 1713 vol viii
n 102 se 1

therefore, obliged to be suckled by a she-goat that was in the house; and that served as a nurse, attending to his cries with a kind of maternal fondness. He began to articulate some words when eighteen months old; and at two years he was able to walk alone. He was then fitted with shoes that were about an inch and a half long. He was attacked with several acute disorders; but the small-pox was the only one which left any marks behind it. Until he was six years old, he eat no other food but pulse, potatoes, and bacon. His father and mother were, from then poverty, incapable of affording him any better nourishment, and his education was little better than his food, being bred up among the rustics of the place. At six years old he was about fifteen inches high; and his whole body weighed but thirteen pounds. Notwithstanding this, he was well proportioned, and handsome; his health was good, but his understanding scarcely passed the bounds of instinct. It was at that time that the king of Poland, having heard of such a curiosity, had him conveyed to Lunenville, gave him the name of *Baby*, and kept him in his palace.

Baby, having thus quitted the hard condition of a peasant, to enjoy all the comforts and conveniences of life, seemed to receive no alteration from his new way of living, either in mind or person. He preserved the goodness of his constitution till about the age of sixteen, but his body seemed to increase very slowly during the whole time; and his stupidity was such, that all instructions were lost in improving his understanding. He could never be brought to have any sense of religion, nor even to shew the least signs of a reasoning faculty. They attempted to teach him dancing and music, but in vain. he never could make any thing of music; and as for dancing, although he beat time tolerably exact, yet he could never remember the figure, but while his dancing-master stood by to direct his motions. Notwithstanding, a mind thus destitute of understanding was not without its passions, anger and jealousy harassed it at times, nor was he without desires of another nature.

At the age of sixteen, Baby was twenty-nine inches tall; at this he rested, but having thus arrived at his acme, the alterations of puberty, or rather, perhaps, of old age, came fast upon him. From being very beautiful, the poor little creature now became quite deformed; his strength quite

forsook him his back bone began to bend his head hung forward, his legs grew weak one of his shoulders turned awry and his nose grew disproportionably large. With his strength his natural spirits also forsook him and by the time he was twenty he was grown feeble decrepit and marked with the strongest impressions of old age. It had been before remarked by some that he would die of old age before he arrived at thirty and in fact by the time he was twenty two he could scarcely walk a hundred paces being worn out with the multiplicity of his years and bent under the burden of protracted life. In this year he had a cold attended with a slight fever threw him into a kind of lethargy which had a few momentary intervals but he could scarcely be brought to speak. However it is asserted that in the five last years in his life he showed a clearer understanding than in his times of best health but at length he died after enduring great agonies in the twenty second year of his age.

Opposite to this accidental diminution of the human race is that of its extraordinary magnitude. Concerning the reality of a nation of giants there have been many disputes among the learned. Some have affirmed the probability of such a race and others as warmly have denied the possibility of their existence. But it is not from any speculative reasonings upon a subject of this kind that information is to be obtained it is not from the disputes of the scholar but the labours of the enterprising that we are to be instructed in this inquiry. Indeed nothing can be more absurd than what some learned men have advanced upon this subject. It is very unlikely says Cæsar that there should either be dwarfs or giants or if such they cannot be fitted for the usual enjoyment of life and reason. Had man been born a dwarf he could not have been a reasonable creature for to that end he must have a jolt head and then he would not have body and blood enough to supply his brain with spirits or if he had a small head proportionable to his body there would not be brain enough for conducting life. But it is still worse with giants and there could never have been a nation of such for there would not be food enough found in any country to sustain them or if there were beasts sufficient for this purpose there would not be grass enough for their maintenance. But what is still more odd others giants could never be able to support the weight of

their own bodies ; since a man of ten feet high, must be eight times as heavy as one of the ordinary stature , whereas he has but twice the size of muscles to support such a burden and, consequently, would be overloaded with the weight of his own body Such are the theories upon this subject ; and they require no other answer, but that experience proves them both to be false . dwarfs are found capable of life and reason ; and giants are seen to carry their own bodies We have several accounts from mariners, that a nation of giants actually exists ; and mere speculation should never induce us to doubt their veracity.

Ferdinand Magellan was the first who discovered this race of people along the coast towards the extremity of South America Magellan was a Portuguese, of noble extraction , who having long behaved with great bravery, under Albuquerque, the conqueror of India, he was treated with neglect by the court, upon his return Applying, therefore, to the king of Spain, he was intrusted with the command of five ships, to subdue the Molucca islands , upon one of which he was slain It was in his voyage thither, that he happened to winter in St Julian's Bay, an American harbour, forty-nine degrees south of the line. In this desolate region, where nothing was seen but objects of terror, where neither trees nor verdure drest the face of the country, they remained for some months without seeing any human creature They had judged the country to be utterly uninhabitable ; when one day, they saw approaching, as if he had been dropt from the clouds, a man of enormous stature, dancing and singing, and putting dust upon his head, as they supposed, in token of peace This overture for friendship was, by Magellan's command, quickly answered by the rest of his men ; and the giant approaching, testified every mark of astonishment and surprise He was so tall, that the Spaniards only reached his waist, his face was broad, his colour brown, and painted over with a variety of tints , each cheek had the resemblance of a heart drawn upon it, his hair was approaching to whiteness ; he was clothed in skins, and armed with a bow Being treated with kindness, and dismissed with some trifling presents, he soon returned with many more of the same stature ; two of whom the mariners decoyed on ship-board : nothing could be more gentle than they were in the beginning ; they considered the fetters that were preparing for

them as ornaments, and played with them like children with their toys, but when they found for what purpose they were intended, they instantly exerted their amazing strength and broke them in pieces with a very easy effort. This account with a variety of other circumstances has been confirmed by succeeding travellers. Herrera, Sebald Wert, Oliver Van Noort and James le Maire, all correspond in affirming the fact although they differ in many particulars of their respective descriptions. The last voyager we have had, that has seen this enormous race is Commodore Byron. I have talked with the person who first gave the relation of that voyage, and who was the carpenter of the Commodore's ship. He was a sensible understanding man and I believe extremely faithful. By him therefore I was assured in the most solemn manner of the truth of his relation and this account has since been confirmed by one or two publications in all which the particulars are pretty nearly the same. One of the circumstances which most puzzled me to reconcile to probability was that of the horses on which they are described as riding down to the shore. We know the American horse to be of European breed and in some measure to be degenerated from the original. I was at a loss therefore to account how a horse of not more than fourteen hands high was capable of carrying a man of nine feet or in other words an animal almost as large as itself. But the wonder will cease when we consider that so small a beast as an ass will carry a man of ordinary size tolerably well, and the proportion between this and the former instance is nearly exact. We can no longer therefore refuse our assent to the existence of this gigantic race of mankind in what manner they are propagated or under what regulations they live is a subject that remains for future investigation. It should appear however that they are a wandering nation changing their abode with the course of the sun and shifting their situation for the convenience of food, climate or pasture *

This race of giants are described as possessed of great strength and, no doubt they must be very different from those accidental giants that are to be seen in different parts

* Later voyagers have not confirmed this account in some particulars

of Europe. Stature, with these, seems rather their infirmity than their pride; and adds to their burden, without increasing their strength. Of those I have seen, the generality were ill formed and unhealthful; weak in their persons, or incapable of exerting what strength they were possessed of. The same defects of understanding that attended those of suppressed stature, were found in those who were thus overgrown: they were heavy, phlegmatic, stupid, and inclined to sadness. Their numbers, however, are but few; and it is thus kindly ordered by Providence, that as the middle stature is the best fitted for happiness, so the middle ranks of mankind are produced in the greatest variety.

However, mankind seems naturally to have a respect for men of extraordinary stature; and it has been a supposition of long standing, that our ancestors were much taller, as well as much more beautiful, than we. This has been, indeed, a theme of poetical declamation from the beginning; and man was scarcely formed, when he began to deplore an imaginary decay. Nothing is more natural than this progress of the mind, in looking up to antiquity with reverential wonder. Having been accustomed to compare the wisdom of our fathers with our own, in early imbecility, the impression of their superiority remains when they no longer exist, and when we cease to be inferior. Thus the men of every age consider the past as wiser than the present; and the reverence seems to accumulate as our imaginations ascend. For this reason, we allow remote antiquity many advantages, without disputing their title: the inhabitants of uncivilized countries represent them as taller and stronger; and the people of a more polished nation, as more healthy and more wise. Nevertheless, these attributes seem to be only the prejudices of ingenuous minds; a kind of gratitude, which we hope in turn to receive from posterity. The ordinary stature of men, Mr. Derham observes, is, in all probability, the same now as at the beginning. The oldest measure we have of the human figure, is in the monument of Cheops, in the first pyramid of Egypt. This must have subsisted many hundred years before the times of Homer, who is the first that deplores the decay. This monument, however, scarcely exceeds the measure of our ordinary coffins: the cavity is no more than six feet long, two feet wide, and deep in about the same proportion. Several mummies also, of a very early

age are found to be only of the ordinary stature and shew that for these three thousand years at least men have not suffered the least diminution proofs of this in the ancient up in different parts of Euroj at Medauro fits one of our n been left there at the overthrow of Asdrubal Some of our finest antique statues which we learn from Pliny and others to be exactly as big as the life still continue to this day remaining monuments of the superior excellence of their workmen indeed but not of the superiority of their stature We may conclude therefore, that men have been in all ages pretty much of the same size they are at present and that the only difference must have been accidental or perhaps national

As to the superior beauty of our ancestors it is not easy to make the comparison beauty seems a very uncertain charm and frequently is less in the object than in the eye of the beholder Were a modern lady's face formed exactly like the Venus of Medici or the Sleeping Vestal she would scarcely be considered beautiful except by the lovers of antiquity whom of all her admirers perhaps she would be least desirous of pleasing It is true that we have some disorders among us that disfigure the features and from which the ancients were exempt but it is equally true that we want some which were common among them and which were equally deforming As for their intellectual powers these also were probably the same as ours we excel them in the sciences which may be considered as a history of accumulated experience and they excel us in the poetic arts as they had the first rising of all the striking images of Nature

CHAP. XIII

OF MUMMIES, WAX-WORKS, ETC

“MAN* is not content with the usual term of life, but he is willing to lengthen out his existence by art; and although he cannot prevent death, he tries to obviate his dissolution. It is natural to attempt to preserve even the most trifling relics of what has long given us pleasure, nor does the mind separate from the body, without a wish, that even the wretched heap of dust it leaves behind may yet be remembered. The embalming, practised in various nations, probably had its use in this fond desire: an urn filled with ashes, among the Romans, served as a pledge of continuing affection; and even the grassy graves in our own churchyards, are raised above the surface, with the desire that the body below should not be wholly forgotten. The soul, ardent after eternity for itself, is willing to procure, even for the body, a prolonged duration.”

But of all nations, the Egyptians carried this art to the highest perfection: as it was a principle of their religion, to suppose the soul continued only coeval to the duration of the body, they tried every art to extend the life of the one by preventing the dissolution of the other. In this practice they were exercised from the earliest ages; and the mummies they have embalmed in this manner, continue in great numbers to the present day. We are told, in Genesis, that Joseph seeing his father expire, gave orders to his physicians to embalm the body, which they executed in the compass of forty days, the usual time of embalming. Herodotus also, the most ancient of the profane historians, gives us a copious detail of this art, as it was practised, in his time, among the Egyptians. There are

* This chapter I have, in a great measure, translated from Mr Daubenton. Whatever is added from others, is marked with inverted commas

certain mer among them says he who practise embalming is a trade, which they perform with all expedition possible In the first place they draw out the brain through the nostrils with irons adapted to this purpose and in proportion as they evacuate it in this manner they fill up the cavity with aromatics they next cut open the belly near the sides with a sharpened stone and take out the entrails which they cleanse and wash in palm oil having performed this operation they roll them in aromatic powder fill them with myrrh, cassia and other perfumes except incense and replace them sewing up the body again After these precautions they salt the body with nitre and keep it in the salting place for seventy days it not being permitted to preserve it so any longer When the seventy days are accomplished and the body washed once more they swathe it in bands made of linen which have been dipt in a gum the Egyptians use instead of salt When the friends have taken back the body they make a hollow trough something like the shape of a man in which they place the body and thus they enclose in a box preserving the whole as a most precious relic placed against the wall Such are the ceremonies used with regard to the rich As for those who are contented with a humbler preparation they treat them as follows they fill a syringe with an odorous liquor extracted from the cedar tree and without making any incision inject it up the body of the deceased and then keep it in nitre as long as in the former case When the time is expired they evacuate the body of the cedar liquor which had been injected and such is the effect of this operation that the liquor dissolves the intestines and brings them away the nitre also serves to eat away the flesh and leaves only the skin and the bones remaining This done the body is returned to the friends and the embalmer takes no farther trouble about it The third method of embalming those of the meanest condition is merely by purging and cleansing the intestines by frequent injections and preserving the body for a similar term in nitre at the end of which it is restored to the relations

Diodorus Siculus also makes mention of the manner in which these embalmings are performed According to him there were several officers appointed for this purpose,

the first of them, who was called the scribe, marked those parts of the body, on the left side, which were to be opened; the cutter made the incision; and one of those that were to salt it drew out all the bowels, except the heart and the kidneys; another washed them in palm wine and odouriferous liquors; afterwards they anointed for above thirty days with cedar, gum, myrrh, cinnamon, and other perfumes. These aromatics preserved the body entire for a long time, and gave a very agreeable odour. It was not in the least disfigured by this preparation; after which it was returned to the relations, who kept it in a coffin, placed upright against a wall

Most of the modern writers who have treated on this subject, have merely repeated what has been said by Herodotus; and if they add any thing of their own, it is but merely from conjecture. Dumont observes, that it is very probable, that aloes, bitumen, and cinnamon, make a principal part of the composition which is used on this occasion: he adds, that, after embalming, the body is put into a coffin, made of the sycamore-tree, which is almost incorruptible. Mr Grew remarks, that in an Egyptian mummy, in the possession of the Royal Society, the preparation was so penetrating as to enter into the very substance of the bones, and rendered them so black, that they seemed to have been burnt. From this he is induced to believe, that the Egyptians had a custom of embalming their dead, by boiling them in a kind of liquid preparation, until all the aqueous parts of the body were exhaled away; and until the oily or gummy matter had penetrated throughout. He proposes, in consequences of this, a method of macerating, and afterwards of boiling the dead body in oil of walnut

I am, for my own part, of opinion, that there were several ways of preserving dead bodies from putrefaction, and that this would be no difficult matter, since different nations have all succeeded in the attempt. We have an example of this kind among the Guanches, the ancient inhabitants of the island of Teneriff. Those who survived the general destruction of this people by the Spaniards, when they conquered this island, informed them, that the art of embalming was still preserved there; and that there was a tribe of priests among them possessed of the secret,

which they kept concealed as a sacred mystery. As the greatest part of the nation was destroyed the Spaniards could not arrive at a complete knowledge of this art, they only found out a few of the particulars. Having taken out the bowels they washed the body several times in a lee made of the dried bark of the pine tree warmed during the summer by the sun or by a stove in the winter. They afterwards anointed it with butter or the fat of bears which they had previously boiled with odorous herbs such as sage and lavender. After this unction they suffered the body to dry and then repeated the operation as often as it was necessary until the whole substance was impregnated with the preparation. When it was become very light it was then a certain sign that it was fit and properly prepared. They then rolled it up in the dried skins of goats which when they had a mind to save expense they suffered to remain with the hair still growing upon them. Purchas assures us that he has seen mummies of this kind in London and mentions the name of a gentleman who had seen several of them in the island of Teneriff which were supposed to have been two thousand years old but without any certain proofs of such great antiquity. This people who probably came first from the coasts of Africa might have learned this art from the Egyptians as there was a traffic carried on from thence into the most internal parts of Africa.

Father Acosta and Garcilasso de la Vega make no doubt but that the Peruvians understood the art of preserving their dead for a very long space of time. They assert their having seen the bodies of several incas that were perfectly preserved. They still preserved their hair and their eye brows but they had eyes made of gold put in the places of those taken out. They were clothed in their usual habits and seated in the manner of the Indians their arms placed on their breasts. Garcilasso touched one of their fingers and found it apparently as hard as wood and the whole body was not heavy enough to overburden a work man who should attempt to carry it away. Acosta presumes that these bodies were embalmed with a bitumen of which the Indians knew the properties. Garcilasso however is of a different opinion as he saw nothing bituminous about them but

he confesses that he did not examine them very particularly; and he regrets his not having inquired into the methods used for that purpose. He adds, that being a Peruvian, his countrymen would not have scrupled to inform him of the secret, if they really had it still among them.

Garcilasso, thus being ignorant of the secret, makes use of some inductions to throw light upon the subject; he asserts, that the air is so dry and so cold at Cusco, that flesh dries there like wood, without corrupting; and he is of opinion, that they dried the body in snow before they applied the bitumen: he adds, that in the times of the incas, they usually dried the flesh which was designed for the use of the army; and that, when it had lost its humidity, it might be kept without salt, or any other preparation.

It is said, that at Spitzbergen, which lies within the arctic circle, and consequently in the coldest climate, bodies never corrupt, nor suffer any apparent alteration, even though buried for thirty years. Nothing corrupts or putrefies in that climate; the wood which has been employed in building those houses where the train-oil is separated, appears as fresh as the day it was first cut.

If excessive cold, therefore, be thus capable of preserving bodies from corruption, it is not less certain that a great degree of dryness, produced by heat, produces the same effect. It is well known that the men and animals that are buried in the sands of Arabia quickly dry up, and continue in preservation for several ages, as if they had been actually embalmed. It has often happened, that whole caravans have perished in crossing those deserts, either by the burning winds that infest them, or by the sands which are raised by the tempest, and overwhelm every creature in certain ruin. The bodies of those persons are preserved entire; and they are often found in this condition by some accidental passenger. Many authors, both ancient and modern, make mention of such mummies as these; and Shaw says, that he has been assured that numbers of men, as well as other animals, have been thus preserved, for times immemorial, in the burning sands of Saibah, which is a place, he supposes, situate between Rasem and Egypt.

The corruption of dead bodies being entirely caused by the fermentation of the humours whatever is capable of hindering or retarding this fermentation will contribute to their preservation. Both heat and cold though so contrary in themselves, produce similar effects in this particular by drying up the humours. The cold in condensing and thickening them and the heat in evaporating them before they have time to act upon the solids. But it is necessary that these extremes should be constant, for if they succeed each other so as that cold shall follow heat or dryness humidity it must then necessarily happen that corruption must ensue—However in temperate climates there are natural causes capable of preserving dead bodies among which we may reckon the quality of the earth in which they are buried. If the earth be drying and astringent it will imbibe the humidity of the body and it may probably be for this reason that the bodies buried in the monastery of the Cordeliers at Thoulouse do not putrefy but dry in such a manner that they may be lifted up by one arm.

The gums resins and bitumens with which dead bodies are embalmed keep off the impressions which they would else receive from the alteration of the temperature of the air and still more if a body thus prepared be placed in a dry or burning sand the most powerful means will be united for its preservation. We are not to be surprised therefore at what we are told by Chardin of the country of Chorosan in Persia. The bodies which have been previously embalmed and buried in the sands of that country as he assures us are found to petrefy or in other words to become extremely hard and are preserved for several ages. It is asserted that some of them have continued for a thousand years.

The Egyptians as has been mentioned above swathed the body with linen bands and enclosed it in a coffin however it is probable that with all these precautions they would not have continued till now if the tombs or pits in which they were placed had not been dug in a dry chalky soil which was not susceptible of humidity and which was besides covered over with a dry sand of several feet thickness.

The sepulchres of the ancient Egyptians subsist to this

day. Most travellers who have been in Egypt have described those of ancient mummies, and have seen the mummies interred there. These catacombs are within two leagues of the ruins of the city, nine leagues from Grand Cairo, and about two miles from the village of Zaccara. They extend from thence to the Pyramids of Pharaoh, which are about eight miles distant. These sepulchres lie in a field, covered with a fine running sand, of a yellowish colour. The country is dry and hilly; the entrance of the tombs is choaked up with sand; there are many open, but several more that are still concealed. The inhabitants of the neighbouring village have no other commerce, or method of subsisting, but by seeking out mummies, and selling them to such strangers as happen to be at Grand Cairo. This commerce, some years ago, was not only a very common, but a very gainful one. A complete mummy was often sold for twenty pounds. but it must not be supposed that it was bought at such a high price from a mere passion for antiquity, there were much more powerful motives for this traffic. Mummy, at that time, made a considerable article in medicine; and a thousand imaginary virtues were ascribed to it, for the cure of most disorders, particularly of the paralytic kind. There was no shop, therefore, without mummy in it; and no physician thought he had properly treated his patient without adding this to his prescription. Induced by the general repute, in which this supposed drug was at that time, several Jews, both of Italy and France, found out the art of imitating mummy so exactly, that they, for a long time, deceived all Europe. This they did by drying dead bodies in ovens, after having prepared them with myrrh, aloes, and bitumen. Still, however, the request for mummies continued, and a variety of cures were daily ascribed to them. At length, Paræus wrote a treatise on their total inefficacy in physic; and shewed their abuse in loading the stomach, to the exclusion of more efficacious medicines. From that time, therefore, their reputation began to decline; the Jews discontinued their counterfeits, and the trade returned entire to the Egyptians, when it was no longer of value. The industry of seeking after mummies is now totally relaxed, their price merely arbitrary, and just what the curious are willing to give.

In seeking for mummies they first clear away the sand which they may do for weeks together without finding what is wanted. Upon coming to a little square opening of about eighteen feet in depth they descend into it by holes for the feet placed at proper intervals and there they are sure of finding what they seek for. These caves or wells as they call them are hollowed out of a white free stone which is found in all this country, a few feet below the covering of sand. When one gets to the bottom of these which are sometimes forty feet below the surface there are several square openings on each side into passages of ten or fifteen feet wide and these lead to chambers of fifteen or twenty feet square. These are all hewn out of the rock, and in each of the catacombs are to be found several of these apartments communicating with each other. They extend a great way under ground so as to be under the city of Memphis and in a manner to undermine its environs.

In some of the chambers the walls are adorned with figures and hieroglyphics in others the mummies are found in tombs round the apartment hollowed out in the rock. These tombs are upright and cut into the shape of a man with his arms stretched out. There are others found and these in the greatest number in wooden coffins or in cloths covered with bitumen. These coffins or wrappers are covered all over with a variety of ornaments. There are some of them painted and adorned with figures such as that of Death and the leaden seals on which several characters are engraven. Some of these coffins are carved into the human shape but the head alone is distinguishable the rest of the body is all of a piece and terminated by a pedestal while there are some with their arms hanging down and it is by these marks that the bodies of persons of rank are distinguished from those of the meaner order. These are generally found lying on the floor without any profusion of ornaments and in some chambers the mummies are found indiscriminately piled upon each other and buried in the sand.

Many mummies are found lying on their backs their heads turned to the north and their hands placed on the belly. The bands of linen with which these were swathed are found to be more than a thousand yards long, and

of consequence, the number of circunvolutions they make about the body must have been amazing. These were performed by beginning at the head, and ending at the feet; but they contrived it so as to avoid covering the face. However, when the face is entirely uncovered, it moulders into dust immediately upon the admission of the air. When, therefore, it is preserved entire, a slight covering of cloth is so disposed over it, that the shape of the eyes, the nose, and the mouth, are seen under it. Some mummies have been found with a long beard, and hair that reached down to the mid-leg, nails of a surprising length, and some gilt, or at least painted of a gold colour. Some are found with bands upon the breast, covered with hieroglyphics, in gold, silver, or in green, and some with tutelary idols, and other figures of jasper, within their body. A piece of gold also has often been found under their tongues, of about two pistoles value; and, for this reason, the Arabians spoil all the mummies they meet with, in order to get at the gold.

But although art, or accident, has thus been found to preserve dead bodies entire, it must by no means be supposed that it is capable of preserving the exact form and lineaments of the deceased person. Those bodies which are found dried away in the deserts, or in some particular church-yards, are totally deformed, and scarcely any lineaments remain of their external structure. Nor are the mummies preserved by embalming, in a better condition. The flesh is dried away, hardened, and hidden under a variety of bandages; the bowels, as we have seen, are totally removed; and from hence, in the most perfect of them, we see only a shapeless mass of skin discoloured; and even the features scarcely distinguishable. The art, is therefore, an effort rather of preserving the substance than the likeness of the deceased; and has, consequently, not been brought to its highest pitch of perfection. It appears from a mummy, not long since dug up in France, that the art of embalming was more completely understood in the western world than even in Egypt. This mummy, which was dug up at Auvergne, was an amazing instance of their skill, and is one of the most curious relics in the art of preservation. As some peasants, in that part of the world, were digging in a field, near Rion, within about

twenty six paces of the highway between that and the river. Artiers they discovered a tomb about a foot and a half beneath the surface. It was composed only of two stones, one of which formed the body of the sepulchre and the other the cover. This tomb was of free stone seven feet and a half long three feet and a half broad and about three feet high. It was of rude workmanship, the cover had been polished but was without figure or inscription. Within this tomb was placed a leaden coffin four feet seven inches long fourteen inches broad and fifteen high. It was not made coffin fashion but oblong like a box equally broad at both ends and covered with a lid that fitted on like a snuff box, without a hinge. This cover had two holes in it each of about two inches long and very narrow filled with a substance resembling butter but for what purpose intended remains unknown. With in this coffin was a mummy in the highest and most perfect preservation. The internal sides of the coffin were filled with an aromatic substance mingled with clay. Round the mummy was wrapped a coarse cloth in form of a naphin under this were two shirts or shrouds of the most exquisite texture beneath these a bandage which covered all parts of the body like an infant in swaddling clothes still under this general bandage there was another which went particularly round the extremities the hands and the legs. The head was covered with two caps the feet and hands were without any particular bandages and the whole body was covered with an aromatic substance an inch thick. When these were removed and the body exposed naked to view nothing could be more astonishing than the preservation of the whole and the exact resemblance it bore to a body that had been dead a day or two before. It appeared well proportioned except that the head was rather large and the feet small. The skin had all the pliancy and colour of a body lately dead the visage however was of a brownish hue. The belly yielded to the touch all the joints were flexible except those of the legs and feet the fingers stretched forth of themselves when bent inwards. The nails still continued entire and all the marks of the joints both in the fingers the palms of the hands and the soles of the feet remained perfectly visible. The bones

of the arms and legs were soft and pliant, but, on the contrary, those of the skull preserved their rigidity; the hair, which only covered the back of the head, was of a chesnut colour, and about two inches long. The pericranium at top was separated from the skull by an incision, in order to open it for the introducing proper aromatics in the place of the brain, where they were found mixed with clay. The teeth, the tongue, and the ears, were all preserved in perfect form. The intestines were not taken out of the body, but remained pliant and entire, as in a fresh subject; and the breast was made to rise and fall like a pair of bellows. The embalming preparation had a very strong and pungent smell, which the body preserved for more than a month after it was exposed to the air. This odour was perceived wherever the mummy was laid; although it remained there but a very short time, it was even pretended that the peasants of the neighbouring villages were incommoded by it. If one touched either the mummy, or any part of the preparation, the hands smelled of it for several hours after, although washed with water, spirit of wine, or vinegar. This mummy, having remained exposed for some months to the curiosity of the public, began to suffer some mutilations. A part of the skin of the forehead was cut off, the teeth were drawn out, and some attempts were made to pull away the tongue. It was, therefore, put into a glass-case, and shortly after transmitted to the king of France's cabinet at Paris.

There are many reasons to believe this to be the body of a person of the highest distinction: however, no marks remain to assure us either of the quality of the person, or the time of his decease. There are only to be seen some irregular figures on the coffin; one of which represents a kind of stair. There were also some singular characters upon the bandages, which were totally defaced by those who had torn them away. However, it should seem that it had remained for several ages in this state, since the first years immediately succeeding the interment, are usually those in which the body is most liable to decay. It appears also to be a much more perfect method of embalming than that of the Egyptians; as in this the flesh continues with its natural elasticity and colour, the bowels remain entire, and the joints have almost the pliancy which they

had when the person was alive. Upon the whole it is probable that a much less tedious preparation than that used by the Egyptians would have sufficed to keep the body from putrefaction and that an injection of petroleum inwardly and a layer of asphaltum without would have sufficed to have made a mummy and it is remarkable that Auvergne where this was found affords these two substances in sufficient plenty. This art therefore might be brought to greater perfection than it has arrived at hitherto were the art worth preserving. But mankind have long since grown wiser in this respect and think it unnecessary to keep by them a deformed custom which instead of aiding their magnificence must only serve to mortify their pride.

CHAP. XIV.

OF ANIMALS.

LEAVING man we now descend to the lower ranks of animated nature and prepare to examine the life manners and characters of these our humble partners in the creation. But in such a wonderful variety as is diffused around us where shall we begin? The number of beings endued with life as well as we seems at first view infinite. Not only the forest the waters the air teems with animals of various kinds but almost every vegetable every leaf has millions of minute inhabitants each of which fill up the circle of its allotted life and some are found objects of the greatest curiosity. In this seeming exuberance of animals it is natural for ignorance to lie down in hopeless uncertainty and to declare what requires labour to particularize to be utterly inscrutable. It is otherwise however with the active and searching mind no way intimidated with the immense variety it begins the task of numbering grouping and classing all the various kinds that fall within its notice finds every day new relations between the several parts of the creation acquires the art of considering several at a time under one point of view and at last

begins to find that the variety is neither so great nor so inscrutable as was at first imagined. As in a clear night, the number of the stars seems infinite, yet, if we sedulously attend to each in its place, and regularly class them, they will soon be found to diminish, and come within a very scanty computation.

Method is one of the principal helps in natural history, and without it very little progress can be made in this science. It is by that alone we can hope to dissipate the glare, if I may so express it, which arises from a multiplicity of objects at once presenting themselves to the view. It is method that fixes the attention to one point, and leads it, by slow and certain degrees, to leave no part of nature unobserved.

All naturalists, therefore, have been very careful in adopting some method of classing or grouping the several parts of nature; and some have written books of natural history with no other view. These methodical divisions some have treated with contempt,* not considering that books, in general, are written with opposite views, some to be read, and some only to be occasionally consulted. The methodists in natural history, seem to be content with the latter advantage; and have sacrificed to order alone, all the delights of the subject, all the arts of heightening, awakening, or continuing curiosity. But they certainly have the same use in science, that a dictionary has in language, but with this difference, that in a dictionary we proceed from the name to the definition; in a system of natural history, we proceed from the definition to find out the thing. Without the aid of system, nature must still have lain undistinguished, like furniture in a lumber-room every thing we wish for is there indeed, but we know not where to find it. If, for instance, in a morning excursion, I find a plant, or an insect, the name of which I desire to learn, or, perhaps, am curious to know whether already known, in this inquiry I can expect information only from one of these systems, which being couched in a methodical form, quickly directs me to what I seek for. Thus we will suppose that our inquirer has met with a spider, and that he has never seen such an insect before.

* Mr Buffon in his Introduction, &c

He is taught by the writer of a system* to examine whether it has wings and he finds it has none. He therefore is to look for it among the wingless insects, or the Aptera as Linnæus calls them. he then is to see whether the head and breast make one part of the body or are disunited. he finds they make one. he is then to reckon the number of feet and eyes and he finds that it has eight of each. The insect therefore must be either a scorpion or a spider, but he lastly examines its feelers which he finds elevated or clubbed, and by all these marks he at last discovers it to be a spider. Of spiders there are forty seven sorts and by reading the description of each the inquirer will learn the name of that which he desires to know. With the name of the insect, he is also directed to those authors that have given any account of it and the page where that account is to be found. by this means he may know at once what has been said of that animal by others and what there is of novelty in the result of his own researches.

From hence it will appear how useful those systems in natural history are to the inquirer. but having given them all their merit it would be wrong not to observe that they have in general been very much abused. Their authors in general seem to think that they are improvers of natural history when in reality they are but guides. they seem to boast that they are adding to our knowledge while they are only arranging it. These authors also seem to think that the reading of their works and systems is the best method to attain a knowledge of nature. but setting aside the impossibility of getting through whole volumes of a dry long catalogue the multiplicity of whose contents is too great for even the strongest memory, such works rather tell us the names than the history of the creature we desire to inquire after. In these dreary pages every insect or plant that has a name makes us distinguished a figure as the most wonderful or the most useful. The true end of studying nature is to make a just selection to find those parts of it that most conduce to our pleasure or convenience and to leave the rest in neglect. But these systems employing the same degree of attention upon all give us no

opportunities of knowing which most deserves attention; and he who has made his knowledge from such systems only, has his memory crowded with a number of trifling, or minute particulars, which it should be his business and his labour to forget. These books, as was said before, are useful to be consulted, but they are very unnecessary to be read; no inquirer into nature should be without one of them; and, without any doubt, Linnæus deserves the preference.

One fault more, in almost all these systematic writers, and that which leads me to the subject of the present chapter, is, that seeing the necessity of methodical distribution in some parts of nature, they have introduced it into all. Finding the utility of arranging plants, birds, or insects, they have arranged quadrupeds also with the same assiduity; and although the number of these is so few as not to exceed two hundred,* they have darkened the subject with distinctions and divisions, which only serve to puzzle and perplex. All method is only useful in giving perspicuity, where the subject is either dark or copious: but with regard to quadrupeds, the number is but few; many of them we are well acquainted with by habit; and the rest may very readily be known, without any method. In treating of such, therefore, it would be useless to confound the reader with a multiplicity of divisions. as quadrupeds are conspicuous enough to obtain the second rank in nature, it becomes us to be acquainted with, at least, the names of them all. However, as there are naturalists who have gained a name from the excellence of their methods in classing these animals, some readers may desire to have a knowledge of what has been laboriously invented for their instruction. I will just take leave, therefore, to mention the most applauded methods of classing animals, as adopted by Ray, Klein, and Linnæus; for it often happens, that the terms which have been long used in a science, though frivolous, become, by prescription, a part of the science itself.

Ray, after Aristotle, divides all animals into two kinds;

* In Dr Shaw's General Zoology, the number of quadrupeds, not including the cetaceous and seal tribes, amount to five hundred and twelve, besides their varieties

those which have blood and those which are bloodless. In the 1st class he places all the insect tribes. The former he divides into such as breathe through the lungs and such as breathe through gills. These 1st comprehend the fishes. In those which breathe through the lungs some have the heart composed of two ventricles and some have it of one. Of the 1st are all animals of the cetaceous kind all oviparous quadrupeds and serpents. Of those that have two ventricles some are oviparous which are the birds and some viviparous which are quadrupeds. The quadrupeds he divides into such as have a hoof and such as are claw footed. Those with the hoof he divides into such as have it undivided such as have it cloven and such as have the hoof divided into more parts as the rhinoceros and hippopotamus. Animals with the cloven hoof he divides into such as chew the cud as the cow and the sheep and such as are not ruminant as the hog. He divides those animals that chew the cud into four kinds the first have hollow horns which they never shed as the cow the second is of a less species and is of the sheep kind the third is of the goat kind and the last, which have solid horns and shed them annually are of the deer kind. Coming to the claw footed animals he finds some with large claws resembling the fingers of the human hand and these he makes the ape kind. Of the others some have the foot divided in two and have 1 claw to each division these are the camel kind. The elephant makes 1 kind by itself as its claws are covered over by a skin. The rest of the numerous tribe of claw footed animals he divides into two kinds the analogous or such as resemble each other and the anomalous which differ from the rest. The analogous claw footed animals are of two kinds they have more than two cutting teeth in each jaw such as the lion and the dog which are carnivorous or they have but two cutting teeth in each jaw and these are chiefly fed upon vegetables. The carnivorous kinds are divided into the great and the little. The great carnivorous animals are divided into such as have a short snout as the cat and the lion and such as have it long and pointed as the dog and the wolf. The little claw footed carnivorous animals differ from the great in having a proportionably smaller head and a slender body.

that fits them for creeping into holes, in pursuit of their prey, like worms ; and they are therefore called the vermin kind

We see, from this sketch of division and sub-division, how a subject, extremely delightful and amusing in itself, may be darkened and rendered disgusting. But, notwithstanding, Ray seems to be one of the most simple distributors ; and his method is still, and not without reason, adopted by many. Such as have been at the trouble to learn this method, will certainly find it useful ; nor would we be thought, in the least, to take from its merits ; all we contend for is, that the same information may be obtained by a pleasanter and an easier method

It was the great success of Ray's method, that soon after produced such a variety of attempts in the same manner, but almost all less simple, and more obscure. Mr. Klein's method is briefly as follows. he makes the power of changing place, the characteristic mark of animals in general, and he takes their distinctions from their aptitude and fitness for such a change. Some change place by means of feet, or some similar contrivance ; others have wings and feet : some can change place only in water, and have only fins. some go upon earth, without any feet at all : some change place, by moving their shell : and some move only at a certain time of the year. Of such, however, as do not move at all, he takes no notice. The quadrupeds that move chiefly by means of four feet upon land he divides into two orders. The first are the hoofed kind ; and the second, the claw kind. Each of these orders is divided into four families. The first family of the hoofed kind, are the single hoofed, such as the horse, ass, &c. The second family are such as have the hoof cloven into two parts, such as the cow, &c. The third family have the hoof divided into three parts ; and in this family is found only the rhinoceros. The fourth family have the hoof divided into five parts, and in this is only to be found the elephant. With respect to the clawed kind, the first family comprehends those that have but two claws on each foot, as the camel, the second family have three claws, the third, four ; and the fourth, five. This method of taking the distinctions of animals from the organs of motion, is ingenious, but is, at the

same time incomplete and besides, the divisions into which it must necessarily fall is inadequate since for instance in his family with two claws there is but one animal, whereas in his family with five claws there are above a hundred

Brisson who has laboured this subject with great accuracy divides animated nature into nine classes namely quadrupeds cetaceous animals or those of the whale kind birds reptiles or those of the serpent kind cartilaginous fishes, spinous fishes shelled animals, insects and worms He divides the quadrupeds into eighteen orders and takes their distinctions from the number and form of their teeth

But of all those whose systems have been adopted and admired Linnæus is the foremost, as with a studied brevity his system comprehends the greatest variety in the smallest space

According to him the first distinction of animals is to be taken from their internal structure Some have the heart with two ventricles and hot red blood namely quadrupeds and birds The quadrupeds are viviparous and the birds oviparous

Some have the heart with but one ventricle and cold red blood namely amphibia and fishes The amphibia are furnished with lungs the fishes with gills

Some have the heart with one ventricle and cold white serum namely insects and worms the insects have feelers and the worms holders

The distinctions of quadrupeds or animals with paps as he calls them are taken from their teeth He divides them into seven orders to which he gives names that are not easy of translation Primates, or principles with four cutting teeth in each jaw Bruta or brutes with no cutting teeth Feræ or wild beasts with generally six cutting teeth in each jaw Glires or dormice with two cutting teeth both above and below Pecora or cattle with many cutting teeth above and none below Belluæ or beasts with the fore teeth blunt Cete or those of the whale kind with cartilaginous teeth I have but just sketched out this system as being in its own nature the closest abridgment it would take volumes to dilate it to its proper length The names of the different animals

and their classes, alone make two thick octavo volumes; and yet nothing is given but the slightest description of each. I have omitted all criticism also upon the accuracy of the preceding systems. this has been done both by Buffon and Daubenton, not with less truth than humour; for they had too much good sense not to see the absurdity of multiplying the terms of science to no end, and disappointing our curiosity rather with a catalogue of nature's varieties, than a history of nature.

Instead, therefore, of taxing the memory and teasing the patience with such a variety of divisions and subdivisions, I will take leave to class the productions of nature in the most obvious, though not in the most accurate, manner. In natural history, of all other sciences, there is the least danger of obscurity. In morals, or in metaphysics, every definition must be precise, because those sciences are built upon definitions; but it is otherwise in those subjects where the exhibition of the object itself is always capable of correcting the error. Thus it may often happen, that in a lax system of natural history, a creature may be ranked among quadrupeds that belongs more properly to the fish or the insect classes. But that can produce very little confusion, and every reader can thus make a system the most agreeable to his own imagination. It will be of no manner of consequence whether we call a bird or an insect a quadruped, if we are careful in marking all its distinctions. the uncertainty in reasoning, or thinking, that these approximations of the different kinds of animals produce, is but very small, and happens but very rarely: whereas the labour that naturalists have been at to keep the kinds asunder, has been excessive. This, in general, has given birth to that variety of systems which we have just mentioned, each of which seems to be almost as good as the preceding.

Taking, therefore, this latitude, and using method only where it contributes to conciseness or perspicuity, we shall divide animated nature into four classes, namely, Quadrupeds, Birds, Fishes, and Insects. All these seem in general pretty well distinguished from each other by nature; yet there are several instances in which we can scarcely tell whether it is a bird or a quadruped that we are about to examine; whether it is a fish or an insect

that offers to our curiosity Nature is varied by imperceptible gradations so that no line can be drawn between any two classes of its productions and no definition made to comprehend them all. However the distinctions between these classes are sufficiently marked and their encroachments upon each other are so rare that it will be sufficient particularly to apprise the reader when they happen to be blended.

There are many quadrupeds that we are well acquainted with and of those we do not know we shall form the most clear and distinct conceptions by being told wherein they differ and wherein they resemble those with which we are familiar. Each class of quadrupeds may be ranged under some one of the domestic kinds that may serve for the model by which we are to form some kind of idea of the rest. Thus we may say that a tiger is of the cat kind a wolf of the dog kind because there are some rude resemblances between each and a person who has never seen the wild animals will have some incomplete knowledge of their figure from the tame ones. On the contrary I will not as some systematic writers have done * say that the bat is of the human kind or a hog of the horse kind merely because there is some resemblance in their teeth or their paws. For although this resemblance may be striking enough yet a person who has never seen a bat or a hog will never form any just conception of either by being told of this minute similitude. In short the method in classing quadrupeds should be taken from their most striking resemblances and where these do not offer we shall not force the similitude but leave the animal to be described as a solitary species. The number of quadrupeds is so few that indeed without any method whatever there is no great danger of confusion.

All quadrupeds the number of which according to Buffon amounts to but two hundred may be classed in the following manner

First those of the Horse kind. This class contains the Horse the Ass and the Zebra. Of these none have horns and their hoof is of one solid piece.

The second class are those of the Cow kind compre

hending the Uius, the Buffalo, the Bison, and the Bonasus. These have cloven hoofs, and chew the cud.

The third class is that of the sheep kind; with cloven hoofs, and chewing the cud like the former. In this is comprehended the Sheep, the Goat, the Lama, the Vigogne, the Gazella, the Guinea Deer, and all of a similar form.

The fourth class is that of the Deer kind, with cloven hoofs, and with solid horns, that are shed every year. This class contains the Elk, the Rein-deer, the Stag, the Buck, the Roe-buck, and the Axis.

The fifth class comprehends all those of the Hog kind, the Peccari, and the Babyrouessa.

The sixth class is, that numerous one of the Cat kind. This comprehends the Cat, the Lion, the Panther, the Leopard, the Jaguar, the Cougar, the Jaguarette, the Lynx, the Ounce, and the Catamountain. These are all carnivorous, and furnished with crooked claws, which they can sheathe and unsheathe at pleasure.

The seventh class is that of the Dog kind, carnivorous, and furnished with claws like the former, but which they cannot sheathe. This class comprehends the Dog, the Wolf, the Fox, the Jackal, the Isatis, the Hyæna, the Civet, the Gibet, and the Genet.

The eighth class is that of the Weasel kind, with a long small body, with five toes, or claws, on each foot; the first of them separated from the rest like a thumb. This comprehends the Weasel, the Martin, the Pole-cat, the Ferret, the Mangoust, the Vansire, the Ermine, with all the varieties of the American Moufettes.

The ninth class is that of the Rabbit kind, with two large cutting teeth in each jaw. This comprehends the Rabbit, the Hare, the Guinea-pig, all the various species of the Squirrel, the Dormouse, the Marmotte, the Rat, the Mouse, the Agouti, the Paca, the Aperea, and the Tapeti.

The tenth class is that of the Hedge-hog kind, with claw-feet, and covered with prickles; comprehending the Hedge-hog and the Porcupine, the Couando and the Urson.

The eleventh class is that of the Tortoise kind, covered with a shell, or scales. This comprehends the Tortoise, the Pangolin, and the Phatagum.

The twelfth is that of the Otter or amphibious kind, comprehending the Otter the Beaver, the Desman the Morse and the Seal

The thirteenth class is that of the Ape and Monkey kinds with hands and feet resembling hands

The fourteenth class is that of winged quadrupeds or the Bat kind containing the Bat the Flying Squirrel and some other varieties

The animals which seem to approach no other kind either in nature or in form but to make each a distinct species in itself are the following the Elephant the Rhinoceros the Hippopotamos the Camelopard the Camel the Bear the Badger the Tapir the Cabrai the Coati the Ant bear, the Irtou and lastly the Sloth

All other quadrupeds whose names are not set down, will be found among some of the above mentioned classes and referred to that which they most resemble When therefore we are at a loss to know the name of any particular animal by examining which of the known kinds it most resembles either in shape or in hoofs or claws and then examining the particular description we shall be able to discover not only its name but its history I have already said that all methods of this kind are merely arbitrary and that Nature makes no exact distinction between her productions It is hard for instance to tell whether we ought to refer the civet to the dog or the cat kind but if we know the exact history of the civet it is no great matter to which kind we shall judge it to bear the greatest resemblance It is enough that a distribution of this kind excites in us some rude outlines of the make or some marked similitudes in the nature of these animals but to know them with any precision no system or even description will serve since the animal itself or a good print of it must be seen and its history be read at length before it can be said to be known To pretend to say that we have an idea of a quadruped because we can tell the number or the make of its teeth or its paws is as absurd as if we should pretend to distinguish men by the buttons of their clothes Indeed it often happens that the quadruped itself can be but seldom seen that many of the more rare kinds do not come into Europe above once in an age and some of them have never

been able to bear the removal in such a case, therefore there is no other substitute but a good print of the animal, to give an idea of its figure; for no description whatsoever can answer this purpose so well. Mr Locke, with his usual good sense, has observed, that a drawing of the animal, taken from the life, is one of the best methods of advancing natural history; and yet, most of our modern systematic writers are content rather with describing. Descriptions, no doubt, will go some way towards giving an idea of the figure of an animal; but they are certainly much the longest way about, and, as they are usually managed, much the most obscure. In a drawing we can, at a single glance, gather more instruction than by a day's painful investigation of methodical systems, where we are told the proportions with great exactness, and yet remain ignorant of the totality. In fact, this method of describing all things is a fault that has infected many of our books, that treat on the meaner arts, for this last age. They attempt to teach by words, what is only to be learnt by practice and inspection. Most of our dictionaries, and bodies of arts and sciences, are guilty of this error. Suppose, for instance, it be requisite to mention the manner of making shoes, it is plain that all the verbal instructions in the world will never give an adequate idea of this humble art, or teach a man to become a shoemaker. A day or two in a shoemaker's shop will answer the end better than a whole folio of instruction, which only serves to oppress the learner with the weight of its pretended importance. We have lately seen a laborious work carried on at Paris, with this only intent, of teaching all the trades by description. however, the design at first blush seems to be ill considered; and it is probable that very few advantages will be derived from so laborious an undertaking. With regard to the descriptions in natural history, these, without all question, under the direction of good sense, are necessary; but still they should be kept within proper bounds, and, where a thing may be much more easily shewn than described, the exhibition should ever precede the account.

CHAP. XV

OF QUADRUPEDS IN GENERAL, COMPARED TO MAN

UPON comparing the various animals of the globe with each other we shall find that quadrupeds demand the rank immediately next ourselves and consequently come first in consideration. The similitude between the structure of their bodies and ours those instincts which they enjoy in a superior degree to the rest their constant services or their unceasing hostilities all render them the foremost objects of our curiosity the most interesting parts of animated nature. These however although now so completely subdued very probably in the beginning were never upon an equality with us and disputed the possession of the earth. Man while yet savage himself was but ill qualified to civilize the forest. While yet naked unarmed and without shelter every wild beast was a formidable rival and the destruction of such was the first employment of heroes. But when he began to multiply and arts to accumulate he soon cleared the plains of the most noxious of these his rivals a part was taken under his protection and care while the rest found a precarious refuge in the burning desert or the howling wilderness.

From being rivals quadrupeds have now become the assistants of man upon them he devolves the most laborious employments and finds in them patient and humble condutors ready to obey and content with the smallest retribution. It was not however without long and repeated efforts that the independent spirit of these animals was broken for the savage freedom in wild animals is generally found to pass down through several generations before it is totally subdued. Those cats and dogs that are taken from a state of natural wildness in the forest still transmit their fierceness to their young and however concealed in general it breaks out upon several occasions. Thus the assiduity and application of man in bringing them up not only alters their disposition but their very forms, and the difference between animals in

a state of nature and domestic tameness, is so considerable, that Mr. Buffon has taken this as a principal distinction in classing them.

In taking a cursory view of the form of quadrupeds, we may easily perceive, that of all the ranks of animated nature, they bear the nearest resemblance to man. This similitude will be found more striking when, erecting themselves on their hinder feet, they are taught to walk forward in an upright posture. We then see that all their extremities in a manner correspond with ours, and present us with a rude imitation of our own. In some of the ape kind the resemblance is so striking, that anatomists are puzzled to find in what part of the human body man's superiority consists, and scarcely any but the metaphysician can draw the line that divides them.

But if we compare their internal structure with our own, the likeness will be found still to increase, and we shall perceive many advantages they enjoy in common with us, above the lower tribes of nature. Like us, they are placed above the class of birds, by bringing forth their young alive, like us, they are placed above the class of fishes, by breathing through the lungs; like us, they are placed above the class of insects, by having red blood circulating through their veins; and, lastly, like us, they are different from almost all the other classes of animated nature, being either wholly or partly covered with hair. Thus nearly are we represented, in point of conformation, to the class of animals immediately below us; and this shews what little reason we have to be proud of our persons alone, to the perfection of which quadrupeds make such very near approaches.

The similitude of quadrupeds to man obtains also in the fixedness of their nature, and their being less apt to be changed by the influence of climate or food, than the lower ranks of nature *. Birds are found very apt to alter both in colour and size; fishes likewise still more, insects may be quickly brought to change and adapt themselves to the climate; and if we descend to plants, which may be allowed to have a kind of living existence, their kinds may be suprisingly and readily altered, and taught to assume new forms. The

* Buffon, vol. viii p 179

figure of every animal may be considered as a kind of drapery which it may be made to put on or off by human assiduity in man the drapery is almost invariable in quadrupeds it admits of some variation, and the variety may be made greater still as we descend to the inferior classes of animal existence

Quadrupeds although they are thus strongly marked and in general divided from the various kinds around them yet some of them are often of so equivocal a nature that it is hard to tell whether they ought to be ranked in the quadruped class or degraded to those below them If for instance we were to marshal the whole groupe of animals round man placing the most perfect next him and those most equivocal near the classes they most approach we should find it difficult after the principal had taken their stations near him where to place many that lie at the outskirts of this phalanx The bat makes a near approach to the aerial tribe and might by some be reckoned among the birds The porcupine has not less pretensions to that class being covered with quills and shewing that birds are not the only part of nature that are furnished with such a defence The armadillo might be referred to the tribe of insects or snails being like them covered with a shell the seal and the morse might be ranked among the fishes like them being furnished with fins and almost constantly residing in the same element All these the further they recede from the human figure become less perfect and may be considered as the lowest kinds of that class to which we have referred them

But although the variety in quadrupeds is thus great they all seem well adapted to the stations in which they are placed There is scarcely one of them how rudely shaped soever that is not formed to enjoy a state of happiness fitted to its nature All its deformities are only relative to us but all its enjoyments are peculiarly its own We may superficially suppose the sloth that takes up months in climbing a single tree or the mole whose eyes are too small for distant vision are wretched and helpless creatures but it is probable that their life with respect to themselves is a life of luxury the most pleasing food is easily obtained and as they are abridged in one pleasure it may be doubled in those which remain Quadra

ped, and all the lower kinds of animals, have, at worst, but the torments of immediate evil to encounter, and this is but transient and accidental: man has two sources of calamity, that which he foresees, as well as that which he feels; so that, if his reward were to be in this life alone, then, indeed, would he be, of all beings, the most wretched.

The heads of quadrupeds, though differing from each other, are, in general, adapted to their way of living. In some it is sharp, the better to fit the animal for turning up the earth in which its food lies. In some it is long, in order to give a greater room for the olfactory nerves, as in dogs, who are to hunt and find out their prey by the scent. In others it is short and thick, as in the lion, to increase the strength of the jaw, and to fit it the better for combat. In quadrupeds that feed upon grass, they are enabled to hold down their heads to the ground, by a strong tendinous ligament, that runs from the head to the middle of the back. This serves to raise the head although it has been held to the ground for several hours, without any labour, or any assistance from the muscles of the neck.

The teeth of all animals are entirely fitted to the nature of their food. Those of such as live upon flesh differ in every respect from such as live upon vegetables. In the latter they seem entirely made for gathering and bruising their simple food, being edged before, and fitted for cutting; but broad towards the back of the jaw, and fitted for pounding. In the carnivorous kinds, they are sharp before, and fitted rather for holding than dividing. In the one, the teeth serve as grindstones; in the other, as weapons of defence. In both, however, the surface of those teeth which serve for grinding are unequal; the cavities and risings fitting those of the opposite, so as to tally exactly when the jaws are brought together. These inequalities better serve for comminuting the food; but they become smooth with age; and, for this reason, old animals take a longer time to chew their food than such as are in the vigour of life.

Then legs are not better fitted than their teeth to their respective wants or enjoyments. In some they are made for strength only, and to support a vast unwieldy frame,

without much flexibility or beautiful proportion. Thus the legs of the elephant the rhinoceros and the sea horse, resemble pillars: were they made smaller they would be unfit to support the body, were they endowed with greater flexibility or swiftness that would be needless as they do not pursue other animals for food, and conscious of their own superior strength there are none that they deign to avoid. Deers hares and other creatures that are to find safety only in flight have their legs made entirely for speed: they are slender and nervous. Were it not for this advantage every carnivorous animal would soon make them a prey and their races would be entirely extinguished. But in the present state of nature the means of safety are rather superior to those of offence and the pursuing animal must owe success only to patience perseverance and industry. The feet of some that live upon fish alone are made for swimming. The toes of these animals are joined together with membranes being web footed like a goose or a duck by which they swim with great rapidity. Those animals that lead a life of hostility and live upon others have their feet armed with sharp claws which some can sheathe and unsheathe at will. Those on the contrary who lead peaceful lives have generally hoofs which serve some as weapons of defence, and which in all are better fitted for traversing extensive tracts of rugged country than the claw foot of their pursuers.

The stomach is generally proportioned to the quality of the animal's food or the ease with which it is obtained. In those that live upon flesh and such nourishing substances it is small and glandular affording such juices as are best adapted to digest its contents: their intestines also are short, and without fatness. On the contrary such animals as feed entirely upon vegetables have the stomach very large and those who chew the cud have no less than four stomachs all which serve as so many laboratories to prepare and turn their coarse food into proper nourishment. In Africa where the plants afford greater nourishment than in our temperate climates several animals that with us have four stomachs have there but two *

However, in all animals the size of the intestines is proportioned to the nature of the food. where that is furnished in large quantities, the stomach dilates to answer the increase. In domestic animals, that are plentifully supplied, it is large; in the wild animals, that live precariously, it is much more contracted, and the intestines are much shorter.

In this manner, all animals are fitted by nature to fill up some peculiar station. The greatest animals are made for an inoffensive life, to range the plains and the forest without injuring others; to live upon the productions of the earth, the grass of the field, or the tender branches of trees. These, secure in their own strength, neither fly from any other quadrupeds, nor yet attack them: Nature, to the greatest strength, has added the most gentle and harmless dispositions: without this, those enormous creatures would be more than a match for all the rest of the creation; for what devastation might not ensue, were the elephant, or the rhinoceros, or the buffalo, as fierce and as mischievous as the tiger or the rat? In order to oppose these larger animals, and in some measure to prevent their exuberance, there is a species of the carnivorous kind, of inferior strength indeed, but of greater activity and cunning. The lion and the tiger generally watch for the larger kinds of prey, attack them at some disadvantage, and commonly jump upon them by surprise. None of the carnivorous kinds, except the dog alone, will make a voluntary attack, but with the odds on their side. They are all cowards by nature, and usually catch their prey by a bound from some lurking-place, seldom attempting to invade them openly; for the larger beasts are too powerful for them, and the smaller too swift.

A lion does not willingly attack a horse; and then only when compelled by the keenest hunger. The combats between a lion and a horse are frequent enough in Italy; where they are both enclosed in a kind of amphitheatre, fitted for that purpose. The lion always approaches wheeling about, while the horse presents his hinder parts to the enemy. The lion in this manner goes round and round, still narrowing his circle, till he comes to the proper distance to make his spring; just at the time the lion springs, the horse lashes with both legs from behind, and, in general, the odds

are in his favour, it more often happening that the lion is stunned and struck motionless by the blow than that he effects his jump between the horse's shoulders. If the lion is stunned and left sprawling the horse escapes without attempting to improve his victory, but if the lion succeeds he sticks to his prey, and tears the horse in pieces in a very short time.

But it is not among the larger animals of the forest alone that these hostilities are carried on, there is a minuter and a still more treacherous contest between the lower ranks of quadrupeds. The panther hunts for the sheep and the goat the catamountain for the hare or the rabbit and the wild cat for the squirrel or the mouse. In proportion as each carnivorous animal wants strength it uses all the assistance of patience assiduity and cunning. However the arts of these to pursue are not so great as the tricks of their prey to escape so that the power of destruction in one class is inferior to the power of safety in the other. Were this otherwise the forest would soon be dispeopled of the feebler races of animals and beasts of prey themselves would want at one time that subsistence which they lavishly destroyed at another.

Few wild animals seek their prey in the day time they are then generally deterred by their fears of man in the inhabited countries and by the excessive heat of the sun in those extensive forests that lie towards the south and in which they reign the undisputed tyrants. As soon as the morning therefore appears the carnivorous animals retire to their dens and the elephant the horse the deer and all the hare kinds those inoffensive tenants of the plain make their appearance. But again at night fall the state of hostility begins the whole forest then echoes to a variety of different howlings. Nothing can be more terrible than an African landscape at the close of evening the deep toned roarings of the lion the shriller yellings of the tiger the jackal pursuing by the scent and barking like a dog the hyena with a note peculiarly solitary and dreadful but above all the hissing of the various kinds of serpents that then begin their call and as I am assured make a much louder symphony than the birds in our groves in a morning.

Beasts of prey seldom devour each other nor can any

thing but the greatest degree of hunger induce them to it. What they chiefly seek after, is the deer, or the goat; those harmless creatures, that seem made to embellish nature. These are either pursued or surprised, and afford the most agreeable repast to their destroyers. The most usual method with even the fiercest animals, is to hide and crouch near some path frequented by their prey; or some water where cattle come to drink; and seize them at once with a bound. The lion and the tiger leap twenty feet at a spring; and thus, rather than their swiftness or strength, is what they have most to depend upon for a supply. There is scarcely one of the deer or hare kind, that is not very easily capable of escaping them by its swiftness; so that whenever any of these fall a prey, it must be owing to their own inattention.

But there is another class of the carnivorous kind, that hunt by the scent, and which it is much more difficult to escape. It is remarkable, that all animals of this kind pursue in a pack; and encourage each other by their mutual cries. The jackal, the syagush, the wolf, and the dog, are of this kind; they pursue with patience rather than swiftness; their prey flies at first, and leaves them for miles behind; but they keep on with a constant steady pace, and excite each other by a general spirit of industry and emulation, till at last they share the common plunder. But it too often happens, that the larger beasts of prey, when they hear a cry of this kind begun, pursue the pack, and when they have hunted down the animal, come in and monopolize the spoil. This has given rise to the report of the jackal's being the lion's provider; when the reality is, that the jackal hunts for itself, and the lion is an unwelcome intruder upon the fruit of his toil.

Nevertheless, with all the powers which carnivorous animals are possessed of, they generally lead a life of famine and fatigue. Their prey has such a variety of methods for escaping, that they sometimes continue without food for a fortnight together: but nature has endowed them with a degree of patience equal to the severity of their state; so that as their subsistence is precarious, their appetites are complying. They usually seize their prey with a roar, either of seeming delight, or perhaps to terrify it from resistance. They frequently devour it, bones and

all in the most ravenous manner and then retire to their dens continuing inactive till the calls of hunger again excite their courage and industry. But as all their methods of pursuit are counteracted by the arts of evasion they often continue to range without success supporting a state of famine for several days nay sometimes weeks together. Of their prey some find protection in holes in which nature has directed them to bury themselves some find safety by swiftness and such as are possessed of neither of these advantages generally herd together and endeavour to repel invasion by united force. The very sheep which to us seem so defenceless are by no means so in a state of nature they are furnished with arms of defence and a very great degree of swiftness but they are still further assisted by their spirit of mutual defence the females fall into the centre and the males forming a ring round them oppose their horns to the assailants. Some animals that feed upon fruits which are to be found only at one time of the year fill their holes with several sorts of plants which enable them to lie concealed during the hard frosts of the winter contented with their prison since it affords them plenty and protection. These holes are dug with so much art that there seems the design of an architect in the formation. There are usually two apertures by one of which the little inhabitant can always escape when the enemy is in possession of the other. Many creatures are equally careful of avoiding their enemies by placing a centinel to warn them of the approach of danger. These generally perform this duty by turns and they know how to punish such as have neglected their post or have been unmindful of the common safety. Such are a part of the efforts that the weaker races of quadrupeds exert to avoid their invaders and in general they are attended with success. The arts of instinct are most commonly found an overmatch for the invasions of instinct. Man is the only creature against whom all their little tricks cannot prevail. Wherever he has spread his dominion scarcely any flight can save or any retreat harbour wherever he comes terror seems to follow and all society ceases among the inferior tenants of the plain their union against him can yield them no protection and their cunning is but weakness. In their

fellow-brutes, they have an enemy whom they can oppose with an equality of advantage, they can oppose fraud or swiftness to force, or numbers to invasion; but what can be done against such an enemy as man, who finds them out though unseen, and though remote, destroys them? Wherever he comes, all the contest among the meaner ranks seem to be at an end, or is carried on only by surprise. Such as he has thought proper to protect, have calmly submitted to his protection; such as he has found it convenient to destroy, carry on an unequal war, and their numbers are every day decreasing.

The wild animal is subject to few alterations; and, in a state of savage nature, continues for ages the same, in size, shape, and colour. But it is otherwise when subdued, and taken under the protection of man; its external form, and even its internal structure, are altered by human assiduity: and this is one of the first and greatest causes of the variety that we see among the several quadrupeds of the same species. Man appears to have changed the very nature of domestic animals, by cultivation and care. A domestic animal is a slave that seems to have few other desires but such as man is willing to allow it. Humble, patient, resigned, and attentive, it fills up the duties of its station; ready for labour, and content with subsistence.

Almost all domestic animals seem to bear the marks of servitude strong upon them. All the varieties in their colour, all the fineness and length of their hair, together with the depending length of their ears, seem to have arisen from a long continuance of domestic slavery — What an immense variety is there to be found in the ordinary race of dogs and horses! the principal differences of which have been effected by the industry of man, so adapting the food, the treatment, the labour, and the climate, that Nature seems almost to have forgotten her original design; and the tame animal no longer bears any resemblance to its ancestors in the woods around him.

In this manner, nature is under a kind of constraint, in those animals we have taught to live in a state of servitude near us. The savage animals preserve the marks of their first formation; their colours are generally the same;

a rough dusky brown or a tawny seem almost their only varieties. But it is otherwise in the tame their colours are various and their forms different from each other. The nature of the climate indeed operates upon all but more particularly on these. That nourishment which is prepared by the hand of man not adapted to their appetites but to suit his own convenience that climate the rigours of which he can soften and that employment to which they are sometimes assigned produce a number of distinctions that are not to be found among the savage animals. These at first were accidental but in time became hereditary and a new race of artificial monsters are propagated rather to answer the purposes of human pleasure than their own convenience. In short, their very appetites may be changed and those that feed only upon grass may be rendered carnivorous. I have seen a sheep that would eat flesh and a horse that was fond of oysters.

But not their appetites or their figure alone but their very dispositions and their natural sagacity, are altered by the vicinity of man. In those countries where men have seldom intruded some animals have been found established in a kind of civil state of society. Remote from the tyranny of man they seem to have a spirit of mutual benevolence and mutual friendship. The beavers in those distant solitudes are known to build like architects and rule like citizens. The habitations that these have been seen to erect exceed the houses of the human inhabitants of the same country both in neatness and convenience. But as soon as man intrudes upon their society they seem impressed with the terrors of their inferior situation their spirit of society ceases the bond is dissolved and every animal looks for safety in solitude and there tries all its little industry to shift only for itself.

Next to human influence the climate seems to have the strongest effects both upon the nature and the form of quadrupeds. As in man we have seen some alterations produced by the variety of his situation so in the lower ranks that are more subject to variation the influence of climate is more readily perceived. As these are more nearly attached to the earth and in a manner connected

to the soil ; as they have none of the arts of shielding off the inclemency of the weather, or softening the rigours of the sun, they are consequently more changed by its variations. In general it may be remarked, that the colder the country, the larger and the warmer is the fur of each animal, it being wisely provided by Nature, that the inhabitant should be adapted to the rigours of its situation. Thus the fox and wolf, which in temperate climates have but short hair, have a fine long fur in the frozen regions near the pole. On the contrary, those dogs which with us have long hair, when carried to Guinea or Angola, in a short time cast their thick covering, and assume a lighter dress, and one more adapted to the warmth of the country. The beaver, and the ermine, which are found in the greatest plenty in the cold regions, are remarkable for the warmth and delicacy of their furs ; while the elephant, and the rhinoceros, that are natives of the line, have scarcely any hair. Not but that human industry can, in some measure, co-operate with, or repress, the effects of climate in this particular. It is well known what alterations are produced by proper care, in the sheep's fleece, in different parts of our own country ; and the same industry is pursued with a like success in Syria, where many of their animals are clothed with a long and beautiful hair, which they take care to improve, as they work it into that stuff called camblet, so well known in different parts of Europe.

The disposition of the animal seems also not less marked by the climate than the figure. The same causes that seem to have rendered the human inhabitants of the rigorous climates savage and ignorant, have also operated upon their animals. Both at the line and the pole, the wild quadrupeds are fierce and untameable. In these latitudes, their savage dispositions having not been quelled by any efforts from man, and being still farther stimulated by the severity of the weather, they continue fierce and untractable. Most of the attempts which have hitherto been made to tame the wild beasts brought home from the pole or the equator, have proved ineffectual. They are gentle and harmless enough while young ; but as they grow up, they acquire their natural ferocity, and snap at the hand that feeds them. It may indeed, in

general be asserted that in all countries where the men are most barbarous the beasts are most fierce and cruel and this is but a natural consequence of the struggle between man and the more savage animals of the forest for in proportion as he is weak and timid they must be bold and intrusive in proportion as his dominion is but feebly supported their rapacity must be more obnoxious. In the extensive countries therefore lying round the pole or beneath the line the quadrupeds are fierce and formidable. Africa has ever been remarked for the brutality of its men and the fierceness of its animals its lions and its leopards are not less terrible than its crocodiles and its serpents, their dispositions seem entirely marked with the rigours of the climate and being bred in an extreme of heat they shew a peculiar ferocity that neither the force of man can conquer nor his arts allay. However it is happy for the wretched inhabitants of those climates that its most formidable animals are all solitary ones that they have not learnt the art of uniting to oppress mankind but each depending on its own strength invades without any assistant.

The food also is another cause of the variety which we find among quadrupeds of the same kind. Thus the beasts which feed in the valley are generally larger than those which glean a scanty subsistence on the mountain. Such as live in the warm climates where the plants are much larger and more succulent than with us are equally remarkable for their bulk. The ox fed in the plains of Indostan is much larger than that which is more hardily maintained on the side of the Alps. The deserts of Africa where the plants are extremely nourishing produce the largest and fiercest animals and perhaps for a contrary reason America is found not to produce such large animals as are seen in the ancient continent. But whatever be the reason the fact is certain that while America exceeds us in the size of its reptiles of all kinds it is far inferior in its quadruped productions. Thus for instance the largest animal of that country is the tapir which can by no means be compared to the elephant of Africa. Its beasts of prey also are divested of that strength and courage which is so dangerous in this part of the world. The American lion tiger and leopard if

such diminutive creatures deserve these names, are neither so fierce nor so valiant as those of Africa and Asia. The tiger of Bengal has been seen to measure twelve feet in length, without including the tail : whereas the American tiger seldom exceeds three. This difference obtains still more in the other animals of that country, so that some have been of opinion* that all quadrupeds in Southern America are of a different species from those most resembling them in the old world ; and that there are none which are common to both, but such as have entered America by the north ; and which, being able to bear the rigours of the frozen pole, have travelled from the ancient continent, by that passage, into the new. Thus the bear, the wolf, the elk, the stag, the fox, and the beaver, are known to the inhabitants as well of North America as of Russia ; while most of the various kinds to the southward, in both continents, bear no resemblance to each other. Upon the whole, such as peculiarly belong to the new continent are without any marks of the quadruped perfection. They are almost wholly destitute of the power of defence ; they have neither formidable teeth, horns, or tail ; their figure is awkward, and their limbs ill proportioned. Some among them, such as the ant-bear and the sloth, appear so miserably formed, as scarcely to have the power of moving and eating. They, seemingly, drag out a miserable and languid existence in the most desert solitude, and would quickly have been destroyed in a country where there were inhabitants, or powerful beasts to oppose them.

But if the quadrupeds of the new continent be less, they are found in much greater abundance, for it is a rule that obtains through nature, that the smallest animals multiply the fastest. The goat, imported from Europe to South America, soon begins to degenerate ; but as it grows less it becomes more prolific, and, instead of one kid at a time, or two at the most, it generally produces five, and sometimes more. What there is in the food, or the climate, that produces this change, we have not been able to learn ; we might be apt to ascribe it to the heat, but that on the African coast, where it is still hotter, this rule does not

obtain for the goat instead of degenerating there seems rather to improve.

However the rule is general among all quadrupeds that those which are large and formidable produce but few at a time while such as are mean and contemptible are extremely prolific. The lion or tiger have seldom above two cubs at a litter while the cat that is of a similar nature is usually seen to have five or six. In this manner the lower tribes become extremely numerous and but for this surprising fecundity from their natural weakness they would quickly be extirpated. The breed of mice for instance would have long since been blotted from the earth were the mouse as slow in production as the elephant. But it has been wisely provided that such animals as can make but little resistance should at least have a means of repairing the destruction which they must often suffer by their quick reproduction that they should increase even among enemies and multiply under the hand of the destroyer. On the other hand it has as wisely been ordered by Providence that the larger kinds should produce but slowly, otherwise as they require proportional supplies from nature they would quickly consume their own store and of consequence many of them would soon perish through want so that life would thus be given without the necessary means of subsistence. In a word Providence has most wisely balanced the strength of the great against the weakness of the little. Since it was necessary that some should be great and others mean since it was expedient that some should live upon others it has assuaged the weakness of one by granting it fruitfulness and diminished the number of the other by infecundity.

In consequence of this provision the larger creatures which bring forth few at a time seldom begin to generate till they have nearly acquired their full growth. On the contrary those which bring many reproduce before they have arrived at their natural size. Thus the horse and the bull are nearly at their best before they begin to breed the hog and the rabbit scarcely leave the teat before they become parents in turn. Almost all animals likewise continue the time of their pregnancy in proportion to their size. The mare continues eleven months with foal the cow nine

the wolf five, and the bitch nine weeks. In all, the intermediate litters are the most fruitful; the first and the last generally producing the fewest in number, and the worst of the kind

Whatever be the natural disposition of animals at other times, they all acquire new courage when they consider themselves as defending their young. No terrors can then drive them from the post of duty; the mildest begin to exert their little force, and resist the most formidable enemy. Where resistance is hopeless, they then incur every danger, in order to rescue their young by flight, and retard their own expedition by providing for their little ones. When the female opossum, an animal of America, is pursued, she instantly takes her young into a false belly, with which nature has supplied her, and carries them off, or dies in the endeavour. I have been lately assured of a she-fox, which, when hunted, took her cub in her mouth, and run for several miles without quitting it, until at last she was forced to leave it behind, upon the approach of a mastiff, as she ran through a farmer's yard. But, if at this period the mildest animals acquire new fierceness, how formidable must those be that subsist by rapine! At such times, no obstacles can stop their ravage, nor no threats can terrify; the lioness then seems more hardy than even the lion himself. She attacks men and beasts indiscriminately, and carries all she can overcome reeking to her cubs, whom she thus early accustoms to slaughter. Milk, in the carnivorous animals, is much more sparing than in others, and it may be for this reason that all such carry home their prey alive, that, in feeding their young, its blood may supply the deficiencies of nature, and serve instead of that milk with which they are so sparingly supplied.

Nature, that has thus given them courage to defend their young, has given them instinct to choose the proper times of copulation, so as to bring forth when the provision suited to each kind is to be found in the greatest plenty. The wolf, for instance, couples in November, so that the time of pregnancy continuing five months, it may have its young in April. The mare, who goes eleven months, admits the horse in summer, in order to foal about the beginning of May. On the contrary, those animals which lay up pro-

visions for the winter, such as the beaver and the marmotte couple in the latter end of autumn so as to have their young about January against which season they have provided a very comfortable store. These seasons for coupling however among some of the domestic kinds are generally in consequence of the quantity of provisions with which they are at any time supplied. Thus we may by feeding any of these animals and keeping off the rigour of the climate make them breed whenever we please. In this manner those contrive who produce lambs all the year round.

The choice of situation in bringing forth is also very remarkable. In most of the rapacious kinds the female takes the utmost precautions to hide the place of her retreat from the male who otherwise when pressed by hunger would be apt to devour her cubs. She seldom therefore strays far from the den and never approaches it while he is in view nor visits him again till her young are capable of providing for themselves. Such animals as are of tender constitutions take the utmost care to provide a place of warmth as well as safety for their young the rapacious kinds bring forth in the thickest woods those that chew the cud with the various tribes of the vermin kind choose some hiding place in the neighbourhood of man. Some dig holes in the ground some choose the hollow of a tree and all the amphibious kinds bring up their young near the water and accustom them betimes to their proper element.

Thus Nature seems kindly careful for the protection of the meanest of her creatures but there is one class of quadrupeds that seems entirely left to chance that no parent stands forth to protect nor no instructor leads to teach the arts of subsistence. These are the quadrupeds that are brought forth from the egg such as the lizard the tortoise and the crocodile. The fecundity of all other animals compared with these is sterility itself. These bring forth above two hundred at a time but as the offspring is more numerous the parental care is less exerted. Thus the numerous brood of eggs are without farther solicitude buried in the warm sands of the shore and the heat of the sun alone is left to bring them to perfection. To this perfection they arrive almost as soon as disengaged from the shell.

Most of them, without any other guide than instinct, immediately make to the water. In their passage thither, they have numberless enemies to fear. The birds of prey that haunt the shore, the beasts that accidentally come there, and even the animals that give them both, are known, with a strange rapacity, to thin their numbers as well as the rest.

But it is kindly ordered by Providence, that these animals, which are mostly noxious, should thus have many destroyers : were it not for this, by their extreme fecundity, they would soon over-run the earth, and cumber all our plains with deformity.

[“ Thus throughout the whole economy of nature we may trace displays of infinite wisdom, even in regulating the impulses of instinctive power, and in governing its annual or varied tides. A mere system of organized matter, without any independent and intelligent cause, could never have communicated to itself that prescience which the numerous tribes of animals exhibit ; and to ascribe the visible phenomena to chance, is to invest a mere abstract idea with attributes, which, even human knowledge, refined by all the light which philosophy imparts, is scarcely able to comprehend. And even if we allow chance to have been the primitive cause of existence, and of the varied phenomena connected with it, we must ascribe to it that eternity of being which Atheism denies to the intelligent Creator ; unless we conceive that chance, by chance, has begotten chance throughout an infinite series in past duration. The absurdity of such a supposition it would be folly to pursue

“ That many things appear inexplicable in the economy and overruling Providence of God, will be most readily allowed. In every department, shadows, and obscurities, veil from human penetration a considerable portion of his ways. In the vast chain of being, a few links only are open to human inspection, and even these the dimness of our bodily organs and mental powers will not permit us fully to explore. Sometimes even those links which we perceive are not immediately connected together ; and at other times, mists, minuteness, and distance, lay an embargo upon our faculties. It is thus that the parts with which we are surrounded, are intercepted and concealed from our discernment,

while the chain itself stretching into another world can only be discovered by that light, which, in futurity eternity shall impart

‘ In the structure and organs of animals there is an adaptation for certain ends which the most superficial observer can hardly fail to observe. Adaptation implies design and this involves some being or power capable of forming the design and calculating upon issues which no combination of accidents has in any known case ever yet produced. The evidences of wisdom which are scattered over the surface of our globe speak in a language that must be heard even by the most careless and inattentive and the animal world presents us with a noble compendium of facts that are constantly exposed to the scrutiny of every eye. Of these Dr Goldsmith has furnished a grand exhibition and the condition of that reader is not to be envied who after perusing his Natural History can close his book and deliberately think there is no God]

END OF THE FIRST VOLUME

HISTORY

OF THE

EARTH,

AND

ANIMATED NATURE.

IN FOUR VOLUMES.

BY OLIVER GOLDSMITH

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HISTORY OF ANIMALS.

BOOK I.

ANIMALS OF THE HORSE KIND.

CHAP. I.

OF THE HORSE *

ANIMALS of the horse kind deserve a place next to man, in a history of nature. Their activity, their strength, their usefulness, and their beauty, all contribute to render them the principal objects of our curiosity and care, a race of creatures in whose welfare we are interested next to our own.

* As it may happen, that in a description where it is the aim rather to insert what is not usually known, than all that is known, some of the more obvious particulars may be omitted, I will take leave to subjoin in the notes the characteristic marks of each animal, as given us by Linnæus. "The horse, with six cutting teeth before, and single-hoofed, * a native of Europe and the East (but I believe rather of Africa), a generous, proud, and strong animal, fit either for the draught, the course, or the road. he is delighted with woods, he takes care of his hinder parts, defends himself from the flies with his tail, scratches his fellow, defends his young, calls by neighing, sleeps after night-fall, fights by kicking, and by biting also, rolls on the ground when he sweats, eats the grass closer than the ox, distributes the seed by dunging, wants a gall-bladder, never vomits, the foal is produced with the feet stretched out, he is injured by being struck on the ear, upon the stifle, by being caught by the nose in barnacles, by having his teeth rubbed with tallow, by the herb padus, by the herb phalandria, by the cruculio, by the conops. His diseases are different in different countries. A consumption of the ethmoid bones of the nose, called the *glanders*, is with us the most infectious and fatal. He eats hemlock without injury. The mare goes with foal 290 days. The placenta is not fixed. He acquires not the canine teeth till the age of five years.

[* In South America is found a horse whose hoofs are divided, like those of a ruminant quadruped. In its general appearance, size, and colour, it resembles the ass, but has the voice and ears of a horse, and has no bands crossing the shoulders. It is very wild, swift, and strong.]

Of all the quadruped animals the horse seems the most beautiful the noble largeness of his form the glossy smoothness of his skin the graceful ease of his motions and the exact symmetry of his shape have taught us to regard him as the first and as the most perfectly formed, and yet what is extraordinary enough if we examine him internally his structure will be found the most different from that of man of all other quadrupeds whatsoever As the ape approaches us the nearest in internal conformation so the horse is the most remote * a striking proof that there may be oppositions of beauty, and that all grace is not to be referred to one standard

To have an idea of this noble animal in his native simplicity we are not to look for him in the pastures or the stables to which he has been consigned by man but in those wild and extensive plains where he has been originally produced where he ranges without control and riots in all the variety of luxurious nature In this state of happy independence, he disdains the assistance of man which only tends to servitude In those boundless tracts whether of Africa or New Spain where he runs at liberty he seems no way incommoded with the inconveniences to which he is subject in Europe The continual verdure of the fields supplies his wants and the climate that never knows a winter suits his constitution which naturally seems adapted to heat His enemies of the forest are but few for none but the greater kinds will venture to attack him any one of these he is singly able to overcome while at the same time he is content to find safety in society for the wild horses of those countries always herd together

In these countries therefore the horses are often seen feeding in droves of five or six hundred As they do not carry on war against any other race of animals they are satisfied to remain entirely upon the defensive The pastures on which they live satisfy all their appetites and all other precautions are purely for their security in case of a surprise As they are never attacked but at a disadvantage whenever they sleep in the forests they have always one among their number that stands as centinel to give

notice of any approaching danger; and this office they take by turns *. If a man approaches them while they are feeding by day, their centinel walks up boldly near him, as if to examine his strength, or to intimidate him from proceeding; but as the man approaches within pistol-shot, the centinel then thinks it high time to alarm his fellows, thus he does by a loud kind of snorting, upon which they all take the signal, and fly off with the speed of the wind; their faithful centinel bringing up the rear †.

It is not easy to say from what country the horse came originally. It should seem that the colder climates do not agree with his constitution; for although he is found almost in them all, yet his form is altered there, and he is found at once diminutive and ill-shaped. We have the testimony of the ancients that there were wild horses once in Europe; at present, however, they are totally brought under subjection; and even those which are found in America are of a Spanish breed, which being sent thither upon its first discovery, have since become wild, and have spread over all the south of that vast continent almost to the straits of Magellan. These, in general, are a small breed, of about fourteen hands high. They have thick jaws and clumsy joints, their ears and neck also are long, they are easily tamed; for the horse, by nature, is a gentle complying creature, and resists rather from fear than obstinacy. They are caught by a kind of noose, and then held fast by the legs, and tied to a tree, where they are left for two days without food or drink. By that time they begin to grow manageable; and in some weeks they become as tame as if they had never been in a state of wildness. If, by any accident, they are once more set at liberty, they never become wild again, but know their masters, and come to their call. Some of the buccaneers have often been agreeably surprised, after a long absence, to see their faithful horses once more present themselves, with their usual assiduity, and come up, with fond submission, to receive the rein.

These American horses, however, cannot properly be ranked among the wild races, since they were originally

* Dictionnaire Universelle des Animaux, p. 19

† Labat, tom. vii

bred from such as were tame. It is not in the new but the old world that we are to look for this animal in a true state of nature in the extensive deserts of Africa in Arabia, and those wide spread countries that separate Tartary from the more southern nations. Vast droves of these animals are seen wild among the Tartars they are of a small breed extremely swift and very readily evade their pursuers. As they go together they will not admit of being gathered round, though even of their tame horse attempting to gather round him and soon oblige him to seek safety by flight. There are vast numbers also of wild horses to the north of China but they are of a weak timid breed small of stature and useless in war.

At the Cape of Good Hope there are numbers of horses in a state of nature but small vicious and untameable. They are found wild also in several other parts of Africa but the wretched inhabitants of that country either want the art to tame them or seem ignorant of their uses. It is common with the negroes who are carried over from thence to America when they first see a horse to testify both terror and surprise. These poor men seem not to have any knowledge of such a creature and though the horse is probably a native of their own country they have let all the rest of mankind enjoy the benefit of his services without turning them to any advantage at home. In some parts of Africa therefore where the horse runs wild the natives seem to consider him rather in the light of a dunty for food than a useful creature capable of assisting them either in war or in labour. riding seems a refinement that the natives of Angola or Caffraria have not as yet been able to attend to and whenever they catch a horse it is only with an intent to eat him.

But of all countries in the world where the horse runs wild Arabia produces the most beautiful breed the most generous swift and persevering. There are found though not in great numbers in the deserts of that country and the natives use every stratagem to take them. Although they are active and beautiful yet they are not so large as those that are bred up tame they are of a brown colour their mane and tail very short, and the hair black and

tufted * Their swiftness is incredible; the attempt to pursue them in the usual manner of the chase, with dogs, would be entirely fruitless. Such is the rapidity of their flight, that they are instantly out of view, and the dogs themselves give up the vain pursuit. The only method, therefore, of taking them, is by traps hidden in the sand, which entangling their feet, the hunter at length comes up, and either kills them, or carries them home alive. If the horse be young, he is considered among the Arabians as a very great delicacy; and they feast upon him while any part is found remaining. but if, from his shape or vigour, he promises to be serviceable in his more noble capacity, they take the usual methods of taming him, by fatigue and hunger, and he soon becomes a useful domestic animal.

The usual manner of trying their swiftness is by hunting the ostrich. the horse is the only animal whose speed is comparable to that of this creature, which is found in the sandy plains, with which those countries abound. The instant the ostrich perceives itself aimed at, it makes to the mountains, while the horsemen pursues with all the swiftness possible, and endeavours to cut off its retreat. The chase then continues along the plain, while the ostrich makes use of both legs and wings to assist its motion. However, a horse of the first speed is able to outstrip it; so that the poor animal is then obliged to have recourse to art to elude the hunter, by frequently turning: at length, finding all escape hopeless, it hides its head wherever it can, and suffers itself tamely to be taken. If the horse, in a trial of this kind, shews great speed, and is not readily tired, his price becomes proportionably great, and there are some horses valued at a thousand ducats.

But the horses thus caught, or trained in this manner, are at present but very few. the value of Arabian horses, all over the world, has, in a great measure, thinned the deserts of the wild breed, and there are very few to be found in those countries, except such as are tame. The Arabians, as we are told by historians, first began the management of horses in the time of Shaque Ishmael.

* *Mam Descript de l'Afrique*, lib. 1 p 51

Before that they wandered wild along the face of the country neglected and useless but the natives then first began to tame their fierceness and to improve their beauty so that at present they possess a race of the most beautiful horses in the world with which they drive a trade and furnish the stables of princes at immense prices

There is scarcely an Arabian how poor soever but is provided with his horse * They in general make use of mares in their ordinary excursions experience having taught them that they support fatigue thirst and hunger better than the horses are found to do They are also less vicious of a gentler nature and are not so apt to neigh They are more harmless also among themselves not so apt to kick or hurt each other but remain whole days together without the least mischief The Turks on the contrary are not fond of mares and the Arabians sell them such horses as they do not choose to keep for stallions at home They preserve the pedigree of their horses with great care and for several ages back They know their alliances and all their genealogy they distinguish the races by different names and divide them into three classes The first is that of the nobles the ancient breed and unadulterated on either side, the second is that of the horses of the ancient race, but adulterated and the third is that of the common and inferior kind the last they sell at a low price but those of the first class and even of the second amongst which are found horses of equal value to the former are sold extremely dear They know by long experience the race of a horse by his appearance they can tell the name the surname the colour and the marks properly belonging to each When they are not possessed of stallions of the noble race themselves for their mares they borrow from their neighbours paying a proper price as with us and receive a written attestation of the whole In this attestation is contained the name of the horse and the mare and their respective genealogies When the mare has produced her foal new witnesses are called and a new attestation signed in which are described the marks of the foal and the day noted when it was brought forth These attestations

increase the value of the horse, and they are given to the person who buys him. The most ordinary mare of this race sells for five hundred crowns; there are many that sell for a thousand; and some of the very finest kinds for fourteen or fifteen hundred pounds. As the Arabians have no other house but a tent to live in, this also serves them for a stable; so that the mare, the foal, the husband, the wife, and the children, lie all together indiscriminately: the little children are often seen upon the body or the neck of the mare, while these continue inoffensive and harmless, permitting them thus to play with and caress them without any injury. The Arabians never beat their horses: they treat them gently, they speak to them, and seem to hold a discourse; they use them as friends; they never attempt to increase their speed by the whip, nor spur them, but in cases of necessity. However, when this happens, they set off with amazing swiftness, they leap over obstacles with as much agility as a buck, and if the rider happens to fall, they are so manageable that they stand still in the midst of their most rapid career. The Arabian horses are of a middle size, easy in their motions, and rather inclined to leanness than fat. They are regularly dressed every morning and evening, and with such care that the smallest roughness is not left upon their skins. They wash the legs, the mane, and the tail, which they never cut, and which they seldom comb, lest they should thin the hair. They give them nothing to eat during the day; they only give them to drink once or twice, and at sun-set they hang a bag to their heads, in which there is about half a bushel of clean barley. They continue eating the whole night, and the bag is again taken away the next morning. They are turned out to pasture in the beginning of March, when the grass is pretty high, and at which time the mares are given to the stallion. When the spring is past, they take them again from pasture, and they get neither grass nor hay during the rest of the year, barley is then only food, except now and then a little straw. The mane of the foal is always clipped when about a year or eighteen months old, in order to make it stronger and thicker. They begin to break them at two years old, or two years and a half at farthest, they never saddle or bridle them till at

that age and then they are always kept ready saddled at the door of the tent from morning till sun set in order to be prepared against any surprise. They at present seem sensible of the great advantage their horses are to the country there is a law therefore that prohibits the exportation of the mares and such stallions as are brought into England are generally purchased on the eastern shores of Africa, and come round to us by the Cape of Good Hope. They are in general less in stature than our own being not above fourteen or fourteen hands and a half high their motions are much more graceful and swifter than of our own horses, but nevertheless their speed is far from being equal they run higher from the ground their stroke is not so long and close and they are far inferior in bottom. Still however they must be considered as the first and finest breed in the world and that from which all others have derived their principal qualifications. It is even probable that Arabia is the original country of horses since there instead of crossing the breed they take every precaution to keep it entire. In other countries they must continually change the races or their horses would soon degenerate but there the same blood has passed down through a long succession without any diminution either of force or beauty.

The race of Arabian horses has spread itself into Barbary among the Moors and has even extended across that extensive continent to the western shores of Africa. Among the negroes of Gambia and Senegal the chiefs of the country are possessed of horses which though little are very beautiful and extremely manageable. Instead of barley they are fed in those countries with maise bruised and reduced into meal and mixed up with milk when they design to fatten them. These are considered as next to the Arabian horses both for swiftness and beauty but they are rather still smaller than the former. The Italians have a peculiar sport in which horses of this breed run against each other. They have no riders but addles so formed as to flap against the horses sides as they move and thus to spur them forward. They are set to run in a kind of ruled walk about a mile long out of which they never attempt to escape but when they once set forward they never stop although the walk from one

end to the other is covered with a crowd of spectators, which opens and gives way as the horses approach. Our horses would scarcely, in this manner, face a crowd, and continue their speed without a rider, through the midst of a multitude; and indeed it is a little surprising how in such a place the horses find their own way. However, what our English horses may want in sagacity, they make up by their swiftness, and it has been found upon computation, that their speed is nearly one-fourth greater, even carrying a rider, than that of the swiftest Barb without one.

The Arabian breed has been diffused into Egypt as well as Barbary, and into Persia also; where, as we are told by Marcus Paulus, there are studs of ten thousand white mares all together, very fleet, and with the hoof so hard that shoeing is unnecessary. In these countries, they in general give their horses the same treatment that they give in Arabia, except that they litter them upon a bed of their own dung, dried in the sun, and then reduced to powder. When this, which is spread under the horse about five inches thick, is moistened, they dry it again, and spread it as before. The horses of these countries a good deal resemble each other. They are usually of a slender make; their legs fine, bony, and far apart, a thin mane, a fine crest, a beautiful head; the ear small and well pointed; the shoulder thin; the side rounded, without any unsightly prominence; the croup is a little of the longest, and the tail is generally set high. The race of horses, however, is much degenerated in Numidia, the natives having been discouraged from keeping the breed up by the Turks, who seize upon all the good horses, without paying the owners the smallest gratuity for their care in bringing them up. The Tingitani and Egyptians have now, therefore, the fame of rearing the finest horses, both for size and beauty. The smallest of these last are usually sixteen hands high; and all of them shaped, as they express it, with the elegance of an antelope.

Next to the Barb, travellers generally rank the Spanish genet. These horses, like the former, are little, but extremely swift and beautiful. The head is something of the largest; the mane thick; the ears long, but well pointed; the eyes filled with fire; the shoulder thickish, and the

breast full and large The croup round and large the legs beautiful and without hair the pastern a little of the longest as in the Barb and the hoof rather too high Nevertheless they move with great ease and carry themselves extremely well Their most usual colour is black or a dark bay They seldom or never have white legs or white snip The Spaniards who have a groundless aversion to these marks never breed from such as have them They are all branded on the buttock with the owner's name and those of the province of Andalusia pass for the best These are said to possess courage obedience grace and spirit, in a greater degree than even the Barb and for this reason they have been preferred as war horses to those of any other country

The Italian horses were once more beautiful than they are at present for they have greatly neglected the breed Nevertheless there are still found some beautiful horses among them particularly among the Neapolitans who chiefly use them for the draught In general they have large heads and thick necks They are also restive and consequently unmanageable These faults however are recompensed by the largeness of their size by their spirit and the beauty of their motion They are excellent for show and have a peculiar aptitude to prance

The Danish horses are of such an excellent size and so strong a make that they are preferred to all others for the draught There are some of them perfectly well shaped but this is but seldom seen for in general they are found to have a thick neck heavy shoulders long and hollow back and a narrow croup however they all move well and are found excellent both for parade and war They are of all colours and often of whimsical ones some being streaked like the tiger or mottled like the leopard

The German horses are originally from Arabian and Barbary stocks nevertheless they appear to be small and ill shaped it is said also that they are weak and washy with tender hoofs The Hungarian horses on the other hand are excellent for the draught as well as the saddle The Hussars who use them in war usually slit their nostrils which is done as it is said to prevent their neighing but perhaps without any real foundation

The Dutch breed is good for the draught and is generally

used for that purpose over Europe : the best come from the province of Friezland The Flanders' horses are much inferior to the former ; they have most commonly large heads, flat feet, and swollen legs ; which are an essential blemish in horses of this kind.

The French horses are of various kinds ; but they have few that are good. The best horses of that country come from Limosin , they have a strong resemblance to the Barb, and, like them, they are excellent for the chase, but they are slow in coming to perfection they are to be carefully treated while young, and must not be backed till they are eight years old. Normandy furnishes the next best, which, though not so good for the chase, are yet better for war In general, the French horses have the fault of being heavy shouldered, which is opposite to the fault of the Barb, which is too thin in the shoulder, and is consequently apt to be shoulder-slipt

Having mentioned the horses most usually known in Europe, we pass on to those of more distant countries, of whose horses we can only judge by report We mentioned the wild horses of America Such as are tame, if we may credit the latest reports,* are admirable Great numbers of these are bred up to the chase, and are chiefly kept for this purpose, particularly at Quito The hunters as Ulloa informs us, are divided into two classes ; one part on foot, the other on horseback the business of the footmen is to rouse the deer , and that of the horsemen, to hunt it down They all, at break of day, repair to the place appointed, which is generally on the summit of a hill, with every man his greyhound The horsemen place themselves on the highest peaks ; whilst those on foot range the precipices, making an hideous noise, in order to start the deer Thus the company extend themselves three or four leagues, or more, according to their numbers. On starting any game, the horse which first perceives it, sets off, and the rider, being unable to guide or stop him, pursues the chase, sometimes down such a steep slope, that a man on foot, with the greatest care, could hardly keep his legs, from thence he flies up a dangerous ascent, or along the side of a mountain ; so that a person not used to this exercise would think it much safer to

throw himself out of the saddle than commit his life to the precipitate ardour of his horse. The other horses which join in the chase do not wait for the riders to animate them they set forward immediately upon seeing another at full speed and it becomes prudence in the rider to give them their way and at the same time to let them feel the spur to carry him over the precipices. These horses are backed and exercised to this method of hunting and their usual pace is trotting.

There are said to be very good horses in the islands of the Archipelago. Those of Crete were in great reputation among the ancients for their swiftness and force however at present they are but little used even in the country itself because of the unevenness of the ground which is there very rocky and mountainous. The original horses of Morocco are much smaller than the Arabian breed however they are very swift and vigorous. In Turkey there are to be found horses of almost all races Arabians Tartars Hungarians and those natural to the place. The latter are very beautiful and elegant they have a great deal of fire swiftness and management but they are not able to support fatigue they eat little they are easily heated and they have skins so sensible, that they can scarcely bear the rubbing of the stirrup. The Persian horses are in general the most beautiful and most valuable of all the East. The pastures in the plains of Media Persopolis Ardebil and Derbent are excellent for the purpose of rearing them and there were bred in those places vast numbers by order of the government of Persia while that country was under any government. Pietro della Valle prefers the horses of Persia to those of Italy and informs us that they are in general of a middle size and although some are found even of the smallest stature yet that does not impair their beauty or their strength yet in some places they are found of a very good size and as large as the English saddle horses are generally found to be they have all a thin head a fine crest a narrow breast small ears well placed the legs fine the hoof hard and the croup beautiful they are docile spirited nimble hardy courageous and capable of supporting very great fatigue they run very swiftly without being easily fatigued they are strong and easily nourished being only supplied with barley and chopped straw they

are put to grass only for six weeks in the spring; they have always the tail at full length, and there is no such thing as geldings among the number; they are defended from the air, as in England, by body-cloths; they attend them with the most punctual exactness; and they are rid generally in a snaffle, without spurs. Great numbers of these are every year transported into Turkey, but chiefly into the East Indies: however, after all, travellers agree that they are not to be compared to the Arabian horses, either for courage, force, or beauty; and that the latter are eagerly sought, even in Persia.

The horses of India are of a very indifferent kind, being weak and washy. Those which are used by the grandees of the country come from Persia and Arabia; they are fed with a small quantity of hay during the day; and at night they have boiled peas, mixed with sugar and butter, instead of oats or barley: this nourishment supports them, and gives them strength; otherwise they would soon sink and degenerate. Those naturally belonging to the country, are very small and vicious. Some are so very little, that Tavernier reports, that the young Mogul prince, at the age of seven or eight, rode one of those little horses, that was not much larger than a greyhound, and it is not long since one of these was brought over into this country as a present to our Queen, that measures no more than nine hands high: and is not much larger than a common mastiff. It would seem, that climates excessively hot are unfavourable to this animal. In this manner, the horses of the Gold-coast, and of Guinea, are extremely little, but very manageable. It is a common exercise with the grandees of that country, who are excellent horsemen, to dart out their lances before them upon full gallop, and to catch them again before they come to the ground. They have a sport also on horseback, that requires great dexterity in the rider, and a great share of activity in the horse. they strike off a ball, with a battledore, while they are upon a full gallop, and pursuing it, strike it again before it comes to the ground; and this they continue for a mile together, striking sometimes to the right, and sometimes to the left, with amazing speed and agility.

The horses of China are as indifferent as those of India: they are weak, little, ill-shaped, and cowardly. Those of

Corea are not above three feet high almost all the breed there are made geldings and are so timorous, that they can be rendered no way serviceable in war, so that it may be said that the Tartar horses were properly the conquerors of China. These indeed are very serviceable in war and although but of a middle size yet they are surprisingly patient vigorous swift and bold, their hoofs are extremely hard though rather too narrow their heads are fine but rather too little the neck is long and stiff, the legs of the longest and yet with all these faults they are found to be an excellent breed. The Tartars live with their horses pretty much in the same manner as the Arabians do they begin to back them at the age of seven or eight months placing their children upon them who manage them even at that early age. By these means they break them by little and little till at last about the age of six or seven years they are capable of enduring amazing hardships. Thus they have been known to march two or three days without once stopping, to continue five or six without eating any thing except a handful of grass at every eight hours and besides to remain without drinking for four and twenty hours. These horses which are so vigorous in their own country lose all their strength when they are brought into China or the Indies but they thrive pretty well in Persia and Turkey. The race of little Tartars towards the north have also a breed of little horses which they set such a value upon that it is forbidden to sell them to strangers these horses have the very same qualities with those of the larger kind which they probably derive from a similar treatment. There are also very fine horses in Circassia and Mingrelia. There are some greatly esteemed in the Ukraine in Walachia Poland and Sweden but we have no particular accounts of their excellencies or defects.

If we consult the ancients on the nature and qualities of the horses of different countries we learn that the Grecian horses and particularly those of Thessaly had the reputation of being excellent for war that those of Achæa were the largest that were known that the most beautiful came from Egypt which bred great numbers that the horses of Ethiopia were not in esteem from the heat of the country that Arabia and Africa furnished very beautiful horses and

very fit for the course ; that those of Italy, and particularly of Apulia, were very good ; that in Sicily, Capadocia, Syria, Armenia, Media, and Persia, there were excellent horses, equally esteemed for their speed and vigour ; that those of Sardinia and Corsica, though small, were spirited and courageous ; that those of Spain resembled the Parthian horses, in being very well adapted for war, that in Walachia and Transylvania, there were horses with bushy tails, and manes hanging down to the ground, which, nevertheless, were extremely swift and active, that the Danish horses were good leapers ; those of Scandinavia, though little, were well shaped, and possessed of great agility ; that the Flanders' breed was strong ; that the Gaulish horses were good for carrying burdens ; that the German breeds were so bad, so diminutive and ill-shaped, that no use could be made of them ; that the Swiss and Hungarian horses were good ; and, lastly, that those of India were very diminutive and feeble

Such are the different accounts we have of the various races of horses in different parts of the world I have hitherto omitted making mention of one particular breed, more excellent than any that either the ancients or moderns have produced ; and that is our own It is not without great assiduity, and unceasing application, that the English horses are now become superior to those of any other part of the world, for size, strength, swiftness, and beauty. It was not without great attention, and repeated trials of all the best horses in different parts of the world, that we have been thus successful in improving the breed of this animal ; so that the English horses are now capable of performing what no others ever could attain to By a judicious mixture of the several kinds, by the happy difference of our soils, and by our superior skill in management, we have brought this animal to its highest perfection An English horse, therefore, is now known to excel the Arabian in size and swiftness, to be more durable than the Barb, and more hardy than the Persian An ordinary racer is known to go at the rate of a mile in two minutes : and we had one instance, in the admirable Childers, of still greater rapidity He has been frequently known to move above eighty-two feet and a half in a second, or almost a mile in a minute : he has also run round the course of

Newmarket which is very little less than four miles in six minutes and forty seconds. But what is surprising few horses have been since found that ever could equal him and those of his breed have been remarkably deficient.

However this be no horses can any way equal our own either in point of swiftness or strength and these are the qualifications our horsemen seem chiefly to value. For this reason when the French or other foreigners describe our breed they all mention as a fault the awkward and ungainly motion of our horses, they allow them to be very good indeed but they will not grant them an easy or an elegant carriage *. But these writers do not consider that this seeming want of grace is entirely the result of our manner of breaking them. We consult only speed and dispatch in this animal's motions the French and other nations are more anxious for parade and spirit. For this reason we always throw our horses forward while they put them upon their hunches we give them an easy swift gait of going that covers a great deal of ground they on the contrary throw them back giving them a more showy appearance indeed but one infinitely less useful. The fault of our manner of breaking is that the horse is sometimes apt to fall forward the French managed horse never falls before but more usually on one side and for this reason the rider wears stiff boots to guard his legs against such accidents. However it would be a very easy matter to give our horses all that grace which foreigners are so fond of but it would certainly take from their swiftness and durability.

But in what degree of contempt soever foreigners might formerly have held our horses they have for some time perceived their error and our English hunters are considered as the noblest and the most useful horses in the world. Our geldings are therefore sent over to the continent in great numbers and sell at very great prices as for our mares and stallions there is a law prohibiting their exportation and one similar to this is said to have obtained even as early as the times of Athelstan who prohibited their exportation except where designed as presents.

* See Buffon's account of our horses.

Roger de Belegme, created Earl of Shrewsbury by William the Conqueror,* is the first who is recorded to have made attempts towards the mending our native breed. He introduced Spanish stallions into his estate at Powisland in Wales, from which that part of the country was for many ages after famous for a swift and generous race of horses: however, at that time strength and swiftness were more regarded than beauty; the horses' shapes, in time of action, being entirely hid by a coat of armour, which the knights then usually put upon them, either by way of ornament or defence.

The number of our horses in London alone, in the time of king Stephen, is said to have amounted to twenty thousand. However, long after, in the times of queen Elizabeth, the whole kingdom could not supply two thousand horses to form our cavalry. At present, the former numbers seem revived; so that, in the late war, we furnished out above thirteen thousand horsemen, and could, if hard pushed, supply above four times that number. How far this great increase of horses among us may be beneficial, or otherwise, is not the proper business of the present page to discuss; but certain it is, that where horses increase in too great a degree, men must diminish proportionably, as that food which goes to supply the one, might very easily be converted into nourishment to serve the other. But, perhaps, it may be speculating too remotely, to argue for the diminution of their numbers upon this principle, since every manufacture we export into other countries, takes up room, and may have occupied that place, which, in a state of greater simplicity, might have given birth and subsistence to mankind, and have added to population.

Be this as it will, as we have been at such expence and trouble to procure an excellent breed of horses, it is not now to be expected that we should decline the advantages arising from it, just when in our possession. It may be, therefore, the most prudent measure in our legislature, to encourage the breed as an useful branch of commerce, and a natural defence to the country. But how far this end is answered by the breeding up of races, is what most persons, versed in

* British Zoology, vol 1 p 4 To this work I am indebted for several particulars with regard to the native animals of this island

this subject are very apt to question. They assert, that the running horse as the breed has been for a long time refined is unfit for any other service than that of the course being too slight either for the road the chase or the combat and his joints so delicately united as to render him subject to the smallest accidents. They therefore conclude that less encouragement given to racing would be a means of turning us from breeding rather for swiftness than strength, and that we should thus be again famous for our strong hunters which they say are wearing out from among us.

How far this may be fact I will not take upon me to determine being but little versed in a subject that does not properly come within the compass of natural history. In stead therefore of farther expatiating on this well known animals qualifications upon which many volumes might easily be written I will content myself with just mentioning the description of Camerarius in which he professes to unite all the perfections which a horse ought to be possessed of — It must say he have three parts like those of a woman the breast must be broad the hips round and the mane long it must in three things resemble a lion its countenance must be fierce its courage must be great and its fury irresistible it must have three things belonging to the sheep the nose gentleness and patience it must have three of a deer head leg and skin it must have three of a wolf throat neck and hearing it must have three of a fox ear tail and trot three of a serpent memory sight and flexibility and lastly three of a hare, running walking and perseverance *

* It is a curious natural fact that the horse has the singular property of breathing through the nostril only and not through the mouth for in the severest exercise the mouth is never seen open unless the lower

having the manners of the common wild horse but far exceeding it in swiftness. Its head is large and forehead flat and its teeth are only thirty eight in number. But the most singular mark of difference is that the tail is slender like that of the cow and destitute of hair. If its length the lower part only being covered with a long ash coloured hair

CHAP. II

OF THE ASS.*

ALTHOUGH this animal is very easily distinguished from the horse at first sight, yet, upon a closer inspection, the similitude between them is very striking. They have both a similar outline in the external parts; the same conformation within. One would be led, from the great resemblance there is between them, to suppose them of the same species; and that the ass was only a horse degenerated: however, they are perfectly distinct, and there is an inseparable line drawn between them, for the mule they produce is barren. This seems to be the barrier between every species of animals; this keeps them asunder, and preserves the unities of their form. If the mule, or the monster, bred between two animals, whose form nearly approaches, is no longer fertile, we may then conclude, that these animals, however resembling, are of different kinds. Nature has providently stopped the fruitfulness of these ill-formed productions, in order to preserve the form of every animal uncontaminated: were it not for this, the races would quickly be mixed with each other; no one kind would preserve its original perfection; every creature would quickly degenerate; and the world would be stocked with imperfection and deformity.

The horse and the ass, therefore, though so nearly approaching in form, are of two distinct kinds, different in their natures, and were there but one of each kind, both races would then be extinguished. Their shapes and their habits may, indeed, be very nearly alike, but there is something in every animal, besides its conformation or way of life, that determines its specific nature. Thus there is much greater resemblance between the horse and the ass, than between the sheep and the goat; and yet the latter produce an animal that is by no means barren, but which quickly reproduces an offspring resembling the sheep;

* Many parts of this account are extracted from Daubenton and Buffon, which I mention here, to avoid troubling the reader with a multiplicity of quotations.

while the mule of the former is marked with certain sterility. The goat and the sheep may be therefore said to be of one kind although so much unlike in figure while the horse and the ass are perfectly distinct though so closely resembling. It has indeed been said by Aristotle that their male is sometimes prolific this however has not been confirmed by any other testimony although there has elapsed a period of near two thousand years to collect the evidence.

But what tends to put the subject out of dispute is that the two animals are found in a state of nature entirely different. The onager or wild ass is seen in still greater abundance than the wild horse, and the peculiarities of its kind are more distinctly marked than in those of the tame one. Had it been a horse degenerated the likeness would be stronger between them the higher we went to the original stock from whence both have been supposed to be sprung. The wild animals of both kinds would in such a case resemble each other much more than those of the tame kind upon whom art has for a succession of ages been exercising all its force and producing strange habits and new alterations. The contrary however obtains and the wild ass is even more assinine if I may so express it, than that bred in a state of domestic servitude and has even a natural aversion to the horse as the reader will shortly learn.

The wild ass has by some writers been confounded with the zebra but very improperly, for they are of a very different species. The wild ass is not streaked like the zebra nor is his shape so beautiful his figure is pretty much the same as that of the common ass except that he is of a brighter colour and has a white list running from his head to his tail. This animal is found wild in many islands of the Archipelago particularly in that of Cerigo. There are many wild asses in the deserts of Lybia and Numidia that run with such amazing swiftness that scarcely even the coursers of the country can overtake them. When they see a man they set up a horrid baying and stop short all together till he approaches near them they then as if by common consent fly off with great speed and it is upon such occasions that they generally fall into the traps which are previously prepared.

to catch them. The natives take them chiefly upon account of their flesh, which they esteem as delicious eating, and for their skins, of which that kind of leather is made which is called *shagreen*

Olearius relates, that the monarch of Persia invited him on a certain day to be present at an entertainment of a very peculiar nature, which was exhibited in a small building, near the palace, resembling a theatre. After a collation of fruits and sweetmeats, more than thirty of these wild asses were driven into the area, among which the monarch discharged several shot, and some arrows, and in which he was imitated by some of the rest of his attendants. The asses, finding themselves wounded, and no way of escaping, instantly began to attack each other, biting with great fierceness, and braying terribly. In this manner they continued their mutual animosity, while the arrows were poured in from above, until they were all killed. upon which they were ordered to be taken, and sent to the king's kitchen at Ispahan. The Persians esteem the flesh of this animal so highly, that its delicacy is even become a proverb among them. What may be the taste of wild ass's flesh, we are unable to say; but certain it is, that the flesh of the tame ass is the worst that can be obtained, being drier, more tough, and more disagreeable, than horse-flesh. Galen even says that it is very unwholesome. Yet we should not judge hastily upon the different tastes of different people, in the preference they give to certain meats. The climate produces very great changes in the tenderness and the savour of several viands. that beef, for instance, which is so juicy and good in England, is extremely tough and dry when killed under the line; on the contrary, that pork, which is with us so unpalatable in summer, in the warmer latitudes, where it is always hotter than here, is the finest eating they have, and much preferable to any hog's flesh in Europe.

The ass, like the horse, was originally imported into America by the Spaniards, and afterwards by other nations. That country seems to have been peculiarly favourable to this race of animals; and, where they have run wild, they have multiplied in such numbers, that in some places they are become a nuisance. In the kingdom of

Quito the owners of the grounds where they are bred suffer all persons to take away as many as they can, on paying a small acknowledgment, in proportion to the number of days their sport lasts. They catch them in the following manner. A number of persons go on horse back and are attended by Indians on foot. When arrived at the proper places they form a circle in order to drive them into some valley where at full speed they throw the noose and endeavour to halter them. Those creatures, finding themselves enclosed make very furious efforts to escape, and, if only one forces his way through they all follow with an irresistible impetuosity. However when noosed the hunters throw them down and secure them with fetters and thus leave them till the chase is over. Then in order to bring them away with greater facility they pair them with tame beasts of the same kind but this is not easily performed for they are so remarkably fierce that they often hurt the persons who undertake to manage them. They have all the swiftness of horses and neither declivities nor precipices can retard their career. When attacked they defend themselves with their heels and mouth with such activity that without slackening their pace they often maim their pursuers. But the most remarkable property in these creatures is that after carrying their first load their celerity leaves them their dangerous ferocity is lost and they soon contract the stupid look and dulness peculiar to the assinine species. It is also observable that these creatures will not permit a horse to live among them. They always feed together and if a horse happens to stray into the place where they graze they all fall upon him and without giving him the liberty of flying they bite and kick him till they leave him for dead upon the spot *

Such is this animal in its natural state swift fierce and formidable but in the state of tameness the ass presents a very different picture the moment his native liberty is repressed he seems entirely to give up all claims to freedom, and he assumes a patience and submission even humbler than his situation. He is in a state of tameness, the most gentle and quiet of all animals. He suffers with

constancy, and, perhaps, with courage, all the ill-treatment that cruelty and caprice are pleased to inflict. He is temperate with regard to the quantity and the quality of his provision. He is contented with the most neglected weeds; and makes his humble repast upon what the horse and other animals leave behind. If he gives the preference to any vegetable, it is to the plantain, for which he is often seen to neglect every other herb in the pasture. But he is chiefly delicate with respect to his water, he drinks only at the clearest brooks, and chiefly those to which he has been accustomed. He drinks as soberly as he eats; and never, like the horse, dips his nose into the stream. As he is seldom saddled, he frequently rolls himself upon the grass; and lies down, for this purpose, as often as he has an opportunity, without minding what becomes of his burden. He never rolls, like the horse, in the mud; he even fears to wet his feet; and turns out of his way to avoid the dirty parts of a road.

When very young, the ass is sprightly, and even tolerably handsome, but he soon loses these qualifications, either by age or bad treatment, and he becomes slow, stupid, and headstrong. He seems to shew no ardour, except for the female, having been often known to die after the covering. The she-ass is not less fond of her young than the male is of her, and we are assured that she will cross fire and water to protect or rejoin it. This animal is sometimes not less attached to his owner; by whom he is too often abused. He scents him at a distance, and distinguishes him from others in a crowd; he knows the ways he has passed, and the places where he inhabits.

When overloaded, the ass shews the injustice of his master, by hanging down his head and lowering his ears; when he is too hard pressed, he opens his mouth and draws back his lips, in a very disagreeable manner. If his eyes are covered he will not stir a step, and, if he is laid down in such a manner, that one eye is covered with the grass while the other is hidden with a stone, or whatever is next at hand, he will continue fixed in the same situation, and he will not so much as attempt to rise to free himself from those slight impediments. He walks, trots, and gallops, like a horse, but, although he sets out

very freely at first yet he is soon tired, and then no beating will make him mend his pace. It is in vain that his unmerciful rider exerts his whip or his cudgel, the poor little animal bears it all with patience and without a groan and conscious of his own imbecility does not offer even to move.

Notwithstanding the stupid heaviness of his air he may be educated with as much ease as any other animal and several have been brought up to perform and exhibit as a show. In general, however the poor animal is entirely neglected. Man despises this humble useful creature whose efforts are exerted to please him and whose services are too cheaply purchased. The horse is the only favourite and upon him alone all expense and labour are bestowed. He is fed attended and stabled while the ass is abandoned to the cruelty of the lowest rustics or even to the sport of children and instead of gaining by the lessons he receives is always a loser. He is conducted along by blows he is insulted by unnecessary stripes he is overlorded by the lazy, and being generally the property of the poor he shares with them in their wants and their distresses. Thus this faithful animal which were there no horses would be the first of the quadruped kind in our esteem is now considered as nothing his properties and qualifications being found in a higher degree elsewhere he is entirely disregarded and from being the second he is degraded into one of the most useless of the domestic quadrupeds.

For this reason very little care has been taken to improve the breed it is suffered to degenerate and it is probable that of all other animals this alone is rendered feebler and more diminutive by being in a state of domestic servitude. The horse the cow and the sheep are rendered larger by the assiduity of man the ass is suffered to dwindle every generation and particularly in England where it is probable that but for the medicinal qualities of its milk the whole species would have ere now been extinguished. Nevertheless we have good reasons to believe that were the same care bestowed on the ass that is spent upon the horse were the same industry used in crossing the breed and improving it we should see the ass become from his present mean state a very portly and serviceable animal we should find him rival the horse in some of his perfec

tions, and exceed him in others The ass, bulk for bulk, is stronger than the horse, is more sure-footed; and though more slow in his motions, he is much less apt to start out of the way

The Spaniards, of all people in Europe, seem alone to be acquainted with the value of the ass They take all proper precautions to improve the breed; and I have seen a jack-ass, from that country, above fifteen hands high This animal, however, seems originally a native of Arabia A warm climate is known to produce the largest and the best; their size and spirit decline in proportion as they advance into colder regions

Though now so common in all parts of England, the ass was entirely lost among us during the reign of queen Elizabeth Holingshead informs us that our land did yield no asses * However, there are accounts of them being common in England before that time In Sweden, they are at present a sort of rarity; nor does it appear by the last history of Norway, that they have yet reached that country It is in the hotter climates alone that we are to look for the original of this serviceable creature In Guinea, they are larger and more beautiful than even the horses of the same country In Persia, they have two kinds; one of which is used for burdens, being slow and heavy, the other, which is kept for the saddle, being smooth, stately, and nimble They are managed as horses, only that the rider sits nearer the crupper, and they are taught to amble like them They generally cleave their nostrils to give them more room for breathing, and many of these are sold for forty or fifty pounds

The ass is a much more hardy animal than the horse, and liable to fewer diseases Of all animals covered with hair, he is the least subject to vermin, for he has no lice, probably owing to the dryness and the hardness of his skin Like the horse, he is three or four years in coming to perfection, he lives till twenty or twenty-five, sleeps much less than the horse; and never lies down for that purpose, unless very much tired The she-ass goes above eleven months with young, and never brings forth more than one at a time The mule may be engendered either

* British Zoology, vol 1 p 11

between a horse and a she ass or between a jack ass and a mare. The latter breed is every way preferable being larger stronger and better shaped. It is not yet well known whether the animal called the Gimmero be one of these kinds or as is asserted bred between the ass and the bull. While naturalists affirm the impossibility of this mixture the natives of the alpine countries where this animal is bred as strongly insist upon its reality. The common mule is very healthy and will live above thirty years being found very serviceable in carrying burdens particularly in mountainous and stony places where horses are not so sure footed. The size and strength of our asses is at present greatly improved by the importation of Spanish jack asses and it is probable we may come in time to equal the Spaniards in breeding them where it is not uncommon to give fifty or sixty guineas for a mule and indeed in some mountainous countries the inhabitants cannot well do without them. Their manner of going down the precipices of the Alps or the Andes, is very extraordinary and with it we will conclude their history. In these passages on one side are steep eminences and on the other frightful abysses and as they generally follow the direction of the mountain the road instead of lying in a level forms at every little distance steep declivities of several hundred yards downward. These can only be descended by mules and the animal itself seems sensible of the danger and the caution that is to be used in such descents. When they come to the edge of one of these descents they stop without being checked by the rider and if he inadvertently attempts to spur them on they continue immovable. They seem all this time ruminating on the danger that lies before them and preparing themselves for the encounter. They not only attentively view the road but tremble and snort at the danger. Having prepared for the descent they place their fore feet in a posture as if they were stopping themselves they then also put their hinder feet together but a little forward as if they were going to lie down. In this attitude having taken as it were a survey of the road they slide down with the swiftness of a meteor. In the mean time all the rider has to do is to keep himself fast on the saddle without checking the rein for the

least motion is sufficient to disorder the equilibrium of the mule; in which case they both unavoidably perish. But then address, in this rapid descent, is truly wonderful; for, in their swiftest motion, when they seem to have lost all government of themselves, they follow exactly the different windings of the road, as if they had previously settled in their minds the route they were to follow, and taken every precaution for their safety. In this journey, the natives, who are placed along the sides of the mountains, and hold by the roots of the trees, animate the beast with shouts, and encourage him to perseverance. Some mules, after being long used to these journeys, acquire a kind of reputation for their safety and skill, and their value rises in proportion to their fame.*

CHAP III

OF THE ZEBRA

THERE are but three animals of the horse-kind. The horse, which is the most stately and courageous, the ass, which is the most patient and humble, and the zebra, which is the most beautiful, but at the same time the wildest animal in nature. Nothing can exceed the delicate regularity of this creature's colour, or the lustrous smoothness of its skin, but, on the other hand, nothing can be more timid or more untameable.

It is chiefly a native of the southern parts of Africa; and there are whole herds of them often seen feeding in those extensive plains that lie towards the Cape of Good Hope. However, their watchfulness is such, that they will suffer nothing to come near them, and their swiftness so great, that they readily leave every pursuer far behind. The Zebra, in shape, rather resembles the mule, than the horse or the ass. It is rather less than the former, and yet larger than the latter. Its ears are not so long as those of the ass, and yet not so small as in the horse-kind. Like

the ass its head is large its back straight its legs finely placed and its tail tufted at the end like the horse its skin is smooth and close and its hind quarters round and fleshy But its greatest beauty lies in the amazing regularity and elegance of its colours In the male they are white and brown in the female white and black These colours are disposed in alternate stripes over the whole body and with such exactness and symmetry that one would think Nature had employed the rule and compass to paint them These stripes which like so many ribbands are laid all over its body are narrow parallel and exactly separated from each other It is not here as in other parts coloured animals where the tints are blended into each other every stripe here is perfectly distinct and preserves its colour round the body or the limb without any diminution In this manner are the head the body the thighs the legs and even the tail and the ears beautifully streaked so that at a little distance one would be apt to suppose that the animal was dressed out by art and not thus admirably adorned by nature

In the male zebra the head is striped with fine bands of black and white which in a manner centre in the forehead The ears are variegated with a white and dusky brown The neck has broad stripes of the same dark brown running round it leaving narrow white stripes between The body is striped also across the back with broad bands leaving narrower spaces of white between them and ending in points at the sides of the belly which is white except a black line pectinated on each side reaching from between the fore legs along the middle of the belly two thirds of its length There is a line of separation between the trunk of the body and the hinder quarters on each side behind which on the rump is a plot of narrow stripes joined together by a stripe down the middle to the end of the tail The colours are different in the female and in none the stripes seem entirely to agree in form but in all they are equally distinct the hair equally smooth and fine the white shining and unmingled and the black or brown thick and lustrous

Such is the beauty of this creature that it seems by nature fitted to satisfy the pride and the pleasure of man, and formed to be taken into his service Hitherto

however, it appears to have disdained servitude, and neither force nor kindness have been able to wean it from its native independence and ferocity. But this wildness might, perhaps, in time be surmounted: and it is probable, the horse and the ass, when first taken from the forest, were equally obstinate, fierce, and unmanageable. Mr. Buffon informs us that the zebra, from which he took his description, could never be entirely mastered, notwithstanding all the efforts which were tried to tame it. They continued, indeed, to mount it, but then with such precautions as evidently shewed its fierceness, for two men were obliged to hold the reins, while the third ventured upon its back; and even then it attempted to kick whenever it perceived any person approaching. That which is now in the Queen's menagerie, at Buckingham-Gate, is even more vicious than the former; and the keeper who shews it, takes care to inform the spectators of its ungovernable nature. Upon my attempting to approach it, it seemed quite terrified, and was preparing to kick, appearing as wild as if just caught, although taken extremely young, and used with the utmost indulgence. Yet still it is most probable that this animal, by time and assiduity, could be brought under subjection. As it resembles the horse in form, without all doubt it has a similitude of nature, and only requires the efforts of an industrious and skilful nation, to be added to the number of our domestics. It is not *now* known what were the pains and dangers which were first undergone to reclaim the breed of horses from savage ferocity, these, no doubt, made an equal opposition, but, by being opposed by an industrious and enterprising race of mankind, their spirit was at last subdued, and their freedom restrained. It is otherwise with regard to the zebra; it is the native of countries where the human inhabitants are but little raised above the quadruped. The natives of Angola, or Caffia-ria, have no other idea of advantage from horses but as they are good for food; neither the fine stature of the Arabian courser, nor the delicate colourings of the zebra, have any allurements to a race of people, who only consider the quantity of flesh, and not its conformation. The delicacy of the zebra's shape, or the painted elegance of its form, are no more regarded by such, than by the lion

that makes it his prey. For this reason therefore the zebra may hitherto have continued wild because it is the native of a country where there have been no successful efforts made to reclaim it. All pursuits that have been hitherto instituted against it were rather against its life than its liberty. the animal has thus been long taught to consider man as its most mortal enemy and it is not to be wondered that it refuses to yield obedience where it has so seldom experienced mercy. There is a kind of knowledge in all animals that I have often considered with amazement which is that they seem perfectly to know their enemies and to avoid them. Instinct, indeed may teach the deer to fly from the lion or the mouse to avoid the cat but what is the principle that teaches the dog to attack the dog butcher wherever he sees him? In China where the killing and dressing dogs is a trade whenever one of these people moves out all the dogs of the village or the street are sure to be after him. This I should hardly have believed but that I have seen more than one instance of it among ourselves. I have seen a poor fellow who made a practice of stealing and killing dogs for their skins pursued in full cry for three or four streets together by all the bolder breed of dogs while the weaker flew from his presence with affright. How these animals could thus find out their enemy and pursue him appears I own unaccountable but such is the fact and it not only obtains in dogs but in several other animals though perhaps to a less degree. This very probably may have been in some measure a cause that has hitherto kept the zebra in its state of natural wildness and in which it may continue till kinder treatment shall have reconciled it to its pursuers.

It is very likely therefore as a more civilized people are now placed at the Cape of Good Hope which is the chief place where this animal is found that we may have them tamed and rendered serviceable. Nor is its extraordinary beauty the only motive we have for wishing this animal among the number of our dependents its swiftness is said to surpass that of all others so that the speed of a zebra is become a proverb among the Spaniards and Portuguese. It stands better upon its legs also than a horse and is consequently stronger in proportion. Thus if by proper care

we improved the breed, as we have in other instances, we should probably in time to come have a race as large as the horse, as fleet, as strong, and much more beautiful

The zebra, as was said, is chiefly a native of the Cape of Good Hope. It is also found in the kingdom of Angola, and, as we are assured by Lopez, in several provinces also of Barbary. In those boundless forests it has nothing to restrain its liberty, it is too shy to be caught in traps, and therefore seldom taken alive. It would seem, therefore, that none of them have ever been brought into Europe, that were caught sufficiently young, so as to be untinged by their original state of wildness. The Portuguese, indeed, pretend that they have been able to tame them, and that they have sent four from Africa to Lisbon, which were so far brought under, as to draw the King's coach & they add, that the person who sent them over, had the office of notary conferred upon him for his reward, which was to remain to him and his posterity for ever but I do not find this confirmed by any person who says he saw them. Of those which were sent to Brazil, not one could be tamed, they would permit one man only to approach them, they were tied up very short; and one of them, which had by some means got loose, actually killed his groom, having bitten him to death †. Notwithstanding this, I believe, were the zebra taken up very young, and properly treated, it might be rendered as tame as another animal; and Merolla, who saw many of them, asserts, that when tamed, which he speaks of as being common enough, they are not less estimable for their swiftness than their beauty.

This animal, which is neither to be found in Europe, Asia, or America, is nevertheless very easily fed. That which came over into England some years ago, would eat almost any thing, such as bread, meat, and tobacco, that which is now among us, subsists entirely upon hay. As it so nearly resembles the horse and the ass in structure, so it probably brings forth annually as they do. The noise they make is neither like that of a horse or an ass, but more resembling the confused barking of a mastiff dog. In the two which I saw, there was a circumstance that seems to

* Dapper

† Pyrrard tom ii p 376

have escaped naturalists which is that the skin hangs loose below the jaw upon the neck in a kind of dewlap which takes away much from the general beauty. But whether this be a natural or accidental blemish I will not take upon me to determine.

These animals are often sent as presents to the princes of the East. We are told that one of the governors of Batavia gave a zebra which had been sent to him from Africa to the emperor of Japan for which he received as an equivalent for the company a present to the value of sixty thousand crowns *. Peller also relates that the Great Mogul gave two thousand ducats for one of them. And it is frequent with the African ambassadors to the court of Constantinople to bring some of these animals with them as presents for the Grand Signior †

* Navendorf

† In addition to the species may be mentioned the Quagga. This animal which used to be confounded with the zebra is now acknowledged to be quite distinct. It inhabits the same part of Africa as the zebra but is always found in separate herds never associating with it. It is about the same size as the zebra but less elegant in its shape and marks and is of a much more docile nature. The Dutch colonists at the Cape having been able to tame them and use them for the draught and saddle. Its general colour is of a ferruginous tinge with brown stripes. These stripes however are much fewer in number than those of the zebra and much less elegantly disposed there being seldom any on the haunches shoulders and legs and on the hinder parts they gradually diminish into spots.

BOOK II.

OF RUMINATING ANIMALS

CHAP I

INTRODUCTION

OF all animals, those that chew the cud are the most harmless, and the most easily tamed. As they live entirely upon vegetables, it is neither their interest nor their pleasure to make war upon the rest of the brute creation, content with the pastures where they are placed, they seldom desire to change, while they are furnished with a proper supply, and, fearing nothing from each other, they generally go in herds for their mutual security. All the fiercest of the carnivorous kinds seek their food in gloomy solitude; these, on the contrary, range together; the very meanest of them are found to unite in each other's defence; and the hare itself is a gregarious animal, in those countries where it has no other enemies but the beasts of the forests to guard against.

As the food of ruminant animals is entirely of the vegetable kind, and as this is very easily procured, so these animals seem naturally more indolent and less artful than those of the carnivorous kinds, and as their appetites are more simple, their instincts seem to be less capable of variation. The fox or the wolf are for ever prowling; their long habits of want give them a degree of sharpness and cunning, their life is a continued scene of stratagem and escape but the patient ox, or the deer, enjoy the repast that nature has abundantly provided, certain of subsistence, and content with security.

As nature has furnished these animals with an appetite for such coarse and simple nutriment, so she has enlarged the capacity of the intestines, to take in a greater supply. In the carnivorous kinds, as their food is nourishing and juicy, their stomachs are but small, and their intestines short, but in these, whose pasture is coarse, and where much must be

accumulated before any quantity of nourishment can be obtained their stomachs are large and numerous and their intestines long and muscular. The bowels of a ruminating animal may be considered as an elaboratory with vessels in it fitted for various transmutations. It requires a long and tedious process before grass can be transmuted into flesh and for this purpose nature in general has furnished such animals as feed upon grass with four stomachs through which the food successively passes and undergoes the proper separations.*

Of the four stomachs with which ruminant animals are furnished the first is called the *paunch* which receives the food after it has been slightly chewed. the second is called the *honeycomb* and is properly nothing more than a continuation of the former. these two which are very capacious the animal fills as fast as it can and then lies down to ruminate which may be properly considered as a kind of vomiting without effort or pain. The two stomachs above mentioned being filled with as much as they can contain and the grass which was slightly chewed beginning to swell with the heat of the situation it dilates the stomachs and these again contract upon their contents. The aliment thus squeezed has but two passages to escape at one into the third stomach which is very narrow and the other back by the gullet into the mouth which is wider. The greatest quantity therefore is driven back through the largest aperture into the mouth to be chewed a second time while a small part and that only the most liquid is driven into the third stomach through the orifice which is so small. The food which is driven to the mouth and chewed a second time is thus rendered more soft and moist and becomes at last liquid enough to pass into the conduit that goes to the third stomach where it undergoes a still farther comminution. In this stomach which is called the *manifold* from the number of its leaves all which tend to promote digestion the grass has the appearance of boiled spinage but not yet

* All quadrupeds that chew the cud have suet instead of the soft fat of other animals and they have the awkward habit of rising when in a recumbent posture upon their hind legs first. A cow when she rises from the ground places herself on the fore knees and then lifts up the whole hinder parts. A horse springs up first on his fore legs and then rises up his hinder parts. This may be owing to the different conformation of the stomach.

sufficiently reduced, so as to make a part of the animal's nourishment; it requires the operation of the fourth stomach for this purpose, where it undergoes a complete maceration, and is separated to be turned into chyle.

But nature has not been less careful in another respect, in fitting the intestines of these animals for their food. In the carnivorous kinds they are thin and lean, but in ruminating animals they are strong, fleshy, and well covered with fat. Every precaution seems taken that can help their digestion: their stomach is strong and muscular, the more ready to act upon its contents; their intestines are lined with fat, the better to preserve their warmth, and they are extended to a much greater length, so as to extract every part of that nourishment which their vegetable food so scantily supplies.

In this manner are all quadrupeds of the cow, the sheep, or the deer kind, seen to ruminate; being thus furnished with four stomachs, for the macerating of their food. These, therefore, may most properly be called the *ruminant kinds*, although there are many others that have this quality in a less observable degree. The rhinoceros, the camel, the horse, the rabbit, the marmotte, and the squirrel, all chew the cud by intervals, although they are not furnished with stomachs like the former. But not these alone, there are numberless other animals that appear to ruminate, not only birds, but fishes and insects. Among birds are the pelican, the stoik, the heron, the pigeon, and the turtle, these have a power of disgorging their food to feed their young. Among fishes are lobsters, crabs, and that fish called the *dorado*. The salmon also is said to be of this number. and, if we may believe Ovid, the *scarus* likewise; of which he says,*

Of all the fish that graze beneath the flood,
He *only* ruminates his former food

Of insects, the ruminating tribe is still larger, the mole, the cricket, the wasp, the drone, the bee, the grasshopper, and the beetle. All these animals either actually chew the cud, or seem at least to ruminate. They have the stomach composed of muscular fibres, by means whereof the food is ground up and down, in the same manner as in those which

* At contra herbosa pisces hævantur arenæ,
Ut scarus epastus solus qui ruminant escas

are particularly distinguished by the appellation of *ruminants*

But not these alone men themselves have been often known to ruminate and some even with pleasure The recollections of these calamities for such I must consider them incident to our fellow creatures are not very pleasant to read yet I must transcribe a short one as given us by Sharr in the Philosophical Transactions as it may in some measure shew the satisfaction which the lower tribes of animals enjoy while they ruminate The man in question was a citizen of Bristol of about twenty years of age and what seemed more extraordinary still of a ruminating family for his father was frequently subject to the same infirmity or amusement as he himself perhaps would call it This young man usually began to chew his meat over again within about a quarter of an hour after eating His ruminating after a full meal generally lasted about an hour and a half nor could he sleep until this task was performed The victuals upon the return tasted even more pleasantly than at first and returned as if they had been beaten up in a mortar If he ate a variety of things that which he ate first came up again first and if this return was interrupted for any time it produced sickness and disorder and he was never well till it returned Instances of this kind however are rare and accidental and it is happy for mankind that they are so Of all other animals we spend the least time in eating this is one of the great distinctions between us and the brute creation and eating is a pleasure of so low a kind that none but such as are nearly allied to the quadruped desire its prolongation

CHAP II

OF QUADRUPEDS OF THE COW KIND *

Of all ruminant animals those of the cow kind deserve the first rank both for their size their beauty and their ser-

* The animals of this kind have the horns hollow smooth turned outwards and forwards in a semicircular form in the lower jaw there are eight front teeth but none in the upper and there are no tusks in either

vices The horse is more properly an animal belonging to the rich, the sheep chiefly thrives in a flock, and requires attendance; but the cow is more especially the poor man's pride, his riches, and his support. There are many of our peasantry that have no other possession but a cow; and even of the advantages resulting from this most useful creature, the poor are but the nominal possessors. Its flesh they cannot pretend to taste, since then their whole riches are at once destroyed; its calf they are obliged to fatten for sale, since veal is a delicacy they could not make any pretensions to, its very milk is wrought into butter and cheese for the tables of their masters; while they have no share, even in their own possession, but the choice of their market. I cannot bear to hear the rich crying out for liberty while they thus starve their fellow-creatures, and feed them up with an imaginary good, while they monopolize the real benefits of nature.

In those countries where the men are under better subordination, this excellent animal is of more general advantage. In Germany, Poland, and Switzerland, every peasant keeps two or three cows, not for the benefit of his master, but for himself. The meanest of the peasants there kills one cow at least for his own table, which he salts and hangs up, and thus preserves as a delicacy all the year round. There is scarcely a cottage in those countries that is not hung round with these marks of hospitality, and which often make the owner better contented with hunger, since he has it in his power to be luxurious when he thinks proper. A piece of beef hung up there is considered as an elegant piece of furniture, which, though seldom touched, at least argues the possessor's opulence and ease. But it is very different, for some years past, in this country, where our lower rustics at least are utterly unable to purchase meat any part of the year, and by them even butter is considered as an article of extravagance.

The climate and pasture of Great Britain, however, are excellently adapted to this animal's moderate nature; and the verdure and the fertility of our plains are perfectly suited to the manner of its feeding; for wanting the upper fore-teeth, it loves to graze on a high rich pasture. This animal seems but little regardful of the quality of its food, provided it be supplied in sufficient abundance, it makes no pai-

ticular distinction in the choice of its herbage, but indiscriminately and hastily devours the proper quantity. For this reason, in our pastures where the grass is rather high than succulent more flourishing than nutritious the cow thrives admirably and there is no part of Europe where the same animal grows larger, yields more milk or more readily fattens, than with us.

Our pastures supply them with abundance and they in return enrich the pasture, for of all animals the cow seems to give back more than it takes from the soil. The horse and the sheep are known, in a course of years to impoverish the ground. The land where they have fed becomes weedy and the vegetables coarse and unprofitable. on the contrary the pasture where the cow has been bred acquires a finer softer surface and becomes every year more beautiful and even. The reason is that the horse being furnished with fore teeth in the upper jaw nips the grass closely and therefore only chooses that which is the most delicate and tender the sheep also though with respect to its teeth formed like the cow only bites the most succulent parts of the herbage these animals therefore leave all the high weeds standing and while they eat the finer grass too closely suffer the rinker herbage to vegetate and overrun the pasture. But it is other wise with the cow as its teeth cannot come so close to the ground as those of the horse nor so readily as those of the sheep which are less it is obliged to feed upon the tallest vegetables that offer thus it eats them all down and in time levels the surface of the pasture.

The age of the cow is known by the teeth and horns. This animal is furnished with eight cutting teeth in the lower jaw at the age of ten months the two middlemost of these fall out and are replaced by others that are not so white but broader at the age of sixteen months the two next milk white teeth fall out likewise and others come up in their room thus at the end of every six months the creature loses and gains till at the age of three years all the cutting teeth are renewed and then they are long pretty white and equal but in proportion as the animal advances in years they become irregular and black their inequalities become smoother and the animal less capable of chewing its food. Thus the cow often declines from this single cause for as it is obliged to eat a great deal to support life, and as

the smoothness of the teeth makes the difficulty of chewing great, a sufficient quantity of food cannot be supplied to the stomach. Thus the poor animal sinks in the midst of plenty, and every year grows leaner and leaner till it dies.

The horns are another and a surer method of determining this animal's age. At three years old, it sheds its horns, and new ones arise in their place, which continue as long as it lives; at four years of age, the cow has small pointed, neat smooth horns, thickest near the head; at five, the horns become larger, and are marked round with the former year's growth. Thus, while the animal continues to live, the horns continue to lengthen; and every year a new ring is added at the root; so that allowing three years before their appearance, and then reckoning the number of rings, we have, in both together, the animal's age exactly.

As we have indisputably the best breed of horned cattle of any in Europe, so it was not without the same assiduity that we came to excel in these, as in our horses. The breed of cows has been entirely improved by a foreign mixture, properly adapted to supply the imperfections of our own. Such as are purely British are far inferior in size to those on many parts of the continent, but those which we have thus improved by far excel all others. Our Lincolnshire kind derive their size from the Holstein breed, and the large hornless cattle that are bred in some parts of England, came originally from Poland. We were once famous for a wild breed of these animals, but these have long since been worn out, and perhaps no kingdom in Europe can furnish so few wild animals of all kinds as our own. Cultivation and agriculture are sure to banish these wherever they are found, and every addition a country receives from art drives away those animals that are only fitted for a state of nature.

Of all quadrupeds, the cow seems most liable to alteration from its pasture. In the different parts of our own country we easily perceive the great varieties produced among these animals, by the richness or poverty of the soil. In some they grow to a great bulk, and I have seen an ox sixteen hands high, which is taller than the general run of our horses. In others, they appear as diminutive; being not so large as an ass. The breed of the Isle of Man, and most parts of Scotland, is much less in general than in England.

or Ireland they are differently shaped also the dewlap being much smaller and as the expression is the beast has more of the ewe neck This till some years ago was considered in cattle as a deformity and the cow was chosen according to Virgil's direction, with a large dewlap however, at present it is the universal opinion that the cow wants in udder what it has in neck and the larger the dewlap the smaller is the quantity of its milk Our graziers now therefore, endeavour to mix the two breeds the large Holstein with the small northern and from both results that fine mixed breed which excels the cattle of any other part of the world

This difference arising from pasture is more observable in other countries than in our own The cow kind is to be found in almost every part of the world large in proportion to the richness of the pasture and small as the animal is stinted in its food Thus Africa is remarkable for the largest and the smallest cattle of this kind as is also India Poland Switzerland and several other parts of Europe Among the Eluth Tartars where the pastures are remarkably rich and nourishing the cow becomes so large that he must be a tall man who can reach the tip of its shoulder On the contrary in France where the animal is stinted in its food and driven from the most flourishing pastures it greatly degenerates

But the differences in the size of this animal are not so remarkable as those which are found in its form its hair and its horns The difference is so very extraordinary in many of them that they have been even considered as a different kind of creature and names have been given them as a distinct species when in reality they are all the same * In this manner the urus and the bison have been considered from the variety in their make to be distinct in their production but they are all in fact the descendants of one common stock as they have that certain mark of unity they breed and propagate among each other Naturalists have therefore laboured under an obvious error when because of the extreme bulk of the urus or because of the lump upon the back of the bison they assigned them different places in the creation and sepa

rated a class of animals which was really united. It is true, the horse and the ass do not differ so much in form, as the cow and the bison; nevertheless, the former are distinct animals, as their breed is marked with sterility; the latter are animals of the same kind, as their breed is fruitful, and a race of animals is produced, in which the hump belonging to the bison is soon worn away. The differences, therefore, between the cow, the urus, and the bison, are merely accidental. The same caprice in nature that has given horns to some cows, and denied them to others, may also have given the bison a hump, or increased the bulk of the urus; it may have given the one a mane, or denied a sufficiency of hair to the other.

But before we proceed farther, it may be proper to describe these varieties, which have been thus taken for distinct kinds. The urus, or wild bull, is chiefly to be met with in the province of Lithuania; and grows to a size that scarcely any other animal, except the elephant, is found to equal. It is quite black, except a stripe mixed with white, that runs from the neck to the tail, along the top of the back, the horns are short, thick, and strong; the eyes are fierce and fiery, the forehead is adorned with a kind of garland of black curled hair, and some of them are found to have beards of the same, the neck is short and strong, and the skin has an odour of musk. The female, though not so big as the male, exceeds the largest of our bulls in size; nevertheless, her udder and teats are so small, that they can scarcely be perceived. Upon the whole, however, this animal resembles the tame one very exactly, except in some trifling varieties, which his state of wildness, or the richness of the pastures where he is found, may easily have produced.

The bison, which is another variety of the cow kind, differs from the rest, in having a lump between its shoulders. These animals are of various kinds; some very large, others as diminutively little. In general, to regard this animal's fore-parts, he has somewhat the look of a lion, with a long shaggy mane, and a beard under his chin; his head is little, his eyes red and fiery, with a furious look; the forehead is large, and the horns so big, and so far asunder, that

-- This description is chiefly taken from Klein

three men might often sit between them. On the middle of the back there grows a bunch almost as high as that of a camel covered with hair and which is considered as a great delicacy by those that hunt him. There is no pursuing him with safety except in forests where there are trees large enough to hide the hunters. He is generally taken by pit falls the inhabitants of those countries where he is found wild digging holes in the ground and covering them over with boughs of trees and grass then provoking the bison to pursue them they get on the opposite side of the pit fall while the furious animal running head foremost falls into the pit prepared for him and is there quickly overcome and slain.

Besides these real distinctions in the cow kind there have been many others made that appear to be in name only. Thus the *bovinus* of which naturalists have given us long descriptions is supposed by Klein and Buffon to be no more than another name for the bison as the descriptions given of them by the ancients coincide. The *bubalus* also of the ancients which some have supposed to belong to the cow kind Buffon places among the lower class of ruminant quadrupeds as it most resembles them in size shape and the figure of its horns. Of all the varieties therefore of the cow kind there are but two that are really distinct namely the cow and the buffalo these two are separated by nature they seem to bear an antipathy to each other they avoid each other and may be considered as much removed as the horse is from the ass or the zebra. When therefore we have described the varieties of the cow kind we shall pass on to the buffalo which being a different animal requires a separate history.

There is scarcely a part of the world as was said before in which the cow is not found in some one of its varieties either large like the ox or humped as the bison with straight horns or bending inverted backwards or turning sideways to the cheek like those of the ram and in many countries they are found without any horns whatsoever. But to be more particular beginning at the north the few kind which subsist in Iceland are without horns although of the same race originally with ours. The size of these is rather relative to the goodness of the pasture than the warmth or coldness of the climate. The Dutch

frequently bring great quantities of lean cattle from Denmark, which they fatten on their own rich grounds. These are in general of a larger size than their own natural breed, and they fatten very easily. The cattle of the Ukraine, where the pasture is excellent, become very fat, and are considered as one of the largest breeds of Europe. In Switzerland, where the mountains are covered with rich nourishing herbage, which is entirely reserved for them, these animals grow to a very large size. On the contrary, in France, where they get no other grass but what is thought unfit for horses, they dwindle and grow lean. In some parts of Spain the cow grows to a good size; those wild bulls, however, which they pride themselves so much in combating, are a very mean despicable little animal, and somewhat shaped like one of our cows, with nothing of that peculiar steiness of aspect for which our bulls are remarkable. In Barbary, and the provinces of Africa, where the ground is dry, and the pasturage short, the cows are of a very small breed, and give milk in proportion. On the contrary, in Ethiopia, they are of a prodigious bigness. The same holds in Persia and Tartary; where, in some places, they are very small, and, in others, of an amazing stature. It is thus, in almost every part of the world, this animal is found to correspond in size to the quantity of its provision.

If we examine the form of these animals, as they are found tame, in different regions, we shall find, that the breed of the ox, or those without a hump, chiefly occupies the cold and the temperate zones, and is not so much dispersed towards the south. On the contrary, the breed of the bison, or the animal with a hump, is found in all the southern parts of the world, throughout the vast continent of India, throughout Africa, from mount Atlas to the Cape of Good Hope. In all these countries, the bison seems chiefly to prevail; where they are found to have a smooth soft hair, are very nimble of foot, and in some measure supply the want of horses. The bison breed is also more expert and docile than ours, many of them, when they carry burdens, bend their knees to take them up, or set them down. they are treated, therefore, by the natives of those countries, with a degree of tenderness and care equal to their utility, and the respect for them

in India has degenerated even into blind adoration. But it is among the Hottentots where these animals are chiefly esteemed as being more than commonly serviceable. They are their fellow domestics the companions of their pleasures and fatigues. the cow is at once the Hottentot's protector and servant assists him in attending his flocks and guarding them against every invader while the sheep are grazing the faithful backel as this kind of cow is called stands or grazes beside them still however attentive to the looks of its master the backel flies round the field herds in the sheep that are straying obliges them to keep within proper limits and shews no mercy to robbers or even strangers who attempt to plunder. But it is not the plunderers of the flock alone but even the enemies of the nation that these backelies are taught to combat. Every army of Hottentots is furnished with a proper herd of these which are let loose against the enemy when the occasion is most convenient. Being thus sent forward they overturn all before them they strike every opposer down with their horns and trample upon them with their feet and thus often procure their masters an easy victory even before they have attempted to strike a blow. An animal so serviceable it may be supposed is not without its reward. The backel lives in the same cottage with its master and by long habit gains an affection for him and in proportion as the man approaches to the brute so the brute seems to attain even to some share of human sagacity. The Hottentot and his backel thus mutually assist each other and when the latter happens to die a new one is chosen to succeed him by a counsel of the old men of the village. The new backel is then joined with one of the veterans of his own kind from whom he learns his art becomes social and diligent and is taken for life into human friendship and protection.

The bisons or cows with a hump are found to differ very much from each other in the several parts of the world where they are found. The wild ones of this kind as with us are much larger than the tame. Some have horns and some are without any some have them depressed and some raised in such a manner that they are used as weapons of annoyance or defence some are extremely large and others among them such as the zebu

or Barbary cow, are very small. They are all, however, equally docile and gentle when tamed; and, in general, furnished with a fine lustrous soft hair, more beautiful than that of our own breed, their hump is also of different sizes, in some weighing from forty to fifty pounds, in others less. it is not, however, to be considered as a part necessarily belonging to the animal; and probably it might be cut away without much injury. it resembles a gustly fat; and, as I am assured, cuts and tastes somewhat like a dressed udder. The bisons of Malabar, Abyssinia, and Madagascar, are of the great kind, as the pastures there are plentiful. Those of Arabia Petæa, and most parts of Africa, are small, and of the zebu or little kind. In America, especially towards the north, the bison is well known. The American bison, however, is found to be rather less than that of the ancient continent; its hair is longer and thicker, its beard more remarkable, and its hide more lustrous and soft. There are many of them brought up tame in Carolina; however, their wild dispositions still seem to continue, for they break through all fences to get into the corn-fields, and lead the whole tame herd after them, wherever they penetrate. They breed also with the tame kinds originally brought over from Europe; and thus produce a race peculiar to that country.

From all this it appears,* that naturalists have given various names to animals in reality the same, and only differing in some few accidental circumstances. The wild cow and the tame, the animal belonging to Europe, and that of Asia, Africa, and America, the bonasus and the uis, the bison and the zebu, are all one and the same, propagate among each other, and, in the course of a few generations, the hump wears away, and scarcely any vestiges of savage fierceness are found to remain. Of all animals, therefore, except man alone, the cow seems most extensively propagated. Its nature seems equally capable of the rigours of heat and cold. It is an inhabitant as well of the frozen fields of Iceland, as the burning deserts of Lybia. It seems an ancient inmate in every climate,

* Buffon, vol xxiii p 130

domestic and tame in those countries which have been civilized savage and wild in the countries which are less peopled but capable of being made useful in all able to defend itself in a state of nature against the most powerful enemy of the forest and only subordinate to man whose force it has experienced and whose aid it at last seems to require. However wild the calves are which are taken from the dam in a savage state either in Africa or Asia they soon become humble patient and familiar and man may be considered in those countries, as almost helpless without their assistance. Other animals preserve their nature or their form with inflexible perseverance but these in every respect suit themselves to the appetites and conveniences of mankind and as their shapes are found to alter so also does their nature in no animal is there seen a greater variety of kinds and in none a more humble and pliant disposition.

THE BUFFALO

If we should compare the shape of our common cow with that of the bison the difference will appear very great. The shaggy mane of the latter the beard the curled forehead the inverted horns the broad breast and the narrow hinder parts give it the appearance rather of a lion than a cow and fit it more for a state of war with mankind than a state of servitude. Yet notwithstanding these appearances both animals are found to be the same or at least so nearly allied that they breed among each other and propagate a race that continues the kind.

On the other hand if we compare the buffalo with our common cow no two animals can be more nearly alike, either in their form or their nature both equally submissive to the yoke both often living under the same roof and employed in the same domestic services the make and the turn of their bodies so much alike that it requires a close attention to distinguish them and yet after all this no two animals can be more distinct or seem to have stronger antipathies to each other *. Were there but one of each

* Buffon

kind remaining, it is probable the race of both would shortly be extinct. However, such is the fixed aversion formed between these creatures, that the cow refuses to breed with the buffalo, which it nearly resembles; while it is known to propagate with the bison, to which it has, in point of form, but a very distant similitude.

The buffalo is, upon the whole, by no means so beautiful a creature as the cow; his figure is more clumsy and awkward, his air is wilder, and he carries his head lower, and nearer the ground, his limbs are less fleshy, and his tail more naked of hair; his body is shorter and thicker than that of the cow kind, his legs are higher, his head smaller, his horns not so round, black, and compressed, with a bunch of curled hair hanging down between them; his skin is also harder and thicker, more black, and less furnished with hair, his flesh, which is hard and blackish, is not only disagreeable to the taste, but likewise to the smell. The milk of the female is by no means so good as that of the cow, it is however produced in great abundance. In the warm countries, almost all their cheese is made of the milk of the buffalo, and they supply butter also in large quantities. The veal of the young buffalo is not better eating than the beef of the old. The hide of this animal seems to be the most valuable thing he furnishes. The leather made of it is well known for its thickness, softness, and impenetrability. As these animals are, in general, larger and stronger than the cow, they are usefully employed in agriculture. They are used in drawing burdens, and sometimes in carrying them; being guided by a ring, which is thrust through their nose. Two buffaloes yoked in a waggon, are said to draw more than four strong horses, as their heads and necks are naturally bent downward, they are thus better fitted for the draught, and the whole weight of their bodies is applied to the carriage that is to be drawn forward.

From the size and bulk of the buffalo, we may be easily led to conclude that he is a native of the warmer climates. The largest quadrupeds are generally found in the torrid zone; and the buffalo is inferior, in point of size, only to the elephant, the rhinoceros, or the hippopotamus. The camelopard or the camel may indeed be taller, but they are neither so long, nor near so corpulent. Accordingly,

we find this animal wild in many parts of India and tamed also wherever the natives have occasion for his services. The wild buffaloes are very dangerous animals and are often found to bore travellers to death and then trample them with their feet until they have entirely mangled the whole body. However in the woods they are not so much to be feared as in the plains because in the violence of their pursuit their large horns are apt to be entangled in the branches of the trees which gives those who have been surprised by them time to escape the danger. There is scarcely any other method of avoiding their pursuit they run with great swiftness they overturn a tree of moderate growth and are such swimmers as to cross the largest rivers without any difficulty. In this manner like all other large animals of the torrid zone they are very fond of the water and in the midst of their pursuit often plunge in in order to cool themselves. The negroes of Gambia and the Indians of Malabar where buffaloes are in great abundance take great delight in hunting and destroying them however they never attempt to face the buffalo openly but generally climbing up the tree shoot at him from thence and do not come down till they find they have effectually dispatched him. When they are tamed no animal can be more patient or humble and though by no means so docile as the cow kind yet they go through domestic drudgeries with more strength and perseverance.

Although these animals be chiefly found in the torrid zone yet they are bred in several parts of Europe particularly in Italy where they make the food and the riches of the poor. The female produces but one at a time in the same manner as the cow but they are very different in the times of gestation for the cow as we know goes but nine months, whereas the buffalo continues pregnant for twelve. They are all afraid of fire and perhaps in consequence of this have an aversion to red colours that resemble the colour of flame it is said that in those countries where they are found in plenty no person dares to dress in scarlet. In general they are inoffensive animals if undisturbed as indeed all those which feed upon grass are found to be but when they are wounded or when even but fired at nothing then can stop their fury.

they then turn up the ground with their fore-feet, bellow much louder and more terribly than the bull, and make at the object of their resentment with ungovernable rage. It is happy, in such circumstances, if the person they pursue has a wall to escape over, or some such obstacle, otherwise they soon overtake, and instantly destroy him. It is remarkable, however, that although their horns are so very formidable, they in general make more use of their feet in combat, and rather tread their enemies to death than gore them.

Having thus gone through the history of these animals, it may be proper to observe, that no names have been more indiscriminately used than those of the bull, the urus, the bison, and the buffalo. It therefore becomes such as would have distinct ideas of each, to be careful in separating the kinds, the one from the other, allowing the cow for the standard of all. The urus, whether of the large enormous kind of Lithuania, or the smaller race of Spain, whether with long or short horns, whether with or without long hair in the forehead, is every way the same with what our common breed was before they were taken from the forest, and reduced to a state of servitude. The bison, and all its varieties, which are known by a hump between the shoulders, is also to be ranked in the same class. This animal, whether with crooked or with straight horns, whether they be turned towards the cheek, or totally wanting, whether it be large or diminutive, whatever be its colour, or whatever the length of its hair, whether called the *bonasus* by some, or the *bubalus* by others, is but a variety of the cow kind, with whom it breeds, and with whom of consequence it has the closest connexion. Lastly, the buffalo, though shaped much more like the cow, is a distinct kind by itself, that never mixes with any of the former, that goes twelve months with young, whereas the cow goes but nine, that testifies an aversion to the latter, and, though bred under the same roof, or feeding in the same pasture, has always kept separate, and makes a distinct race in all parts of the world. These two kinds are supposed to be the only real varieties in the cow kind, of which naturalists have given so many varieties. With respect to some circumstances mentioned by travellers, such as that of many kinds defending themselves by voiding their dung against their pursuers, this is a practice which they have in common with other timid creatures when

pursued and arises rather from fear than a desire of defence. The musky smell also by which some have been distinguished is found common to many of these kinds in a state of nature and does not properly make the characteristic marks of any. The particular kind of noise also which some of them are known to make which rather resembles grunting than bellowing or lowing is but a savage variety which many wild animals have and yet lose when brought into a state of tameness. For these reasons Mr Buffon whom I have followed in this description is of opinion that the zebu or little African cow and the grunting or Siberian cow are but different races of the bison as the shape of the horns or the length of the hair are never properly characteristic marks of any animal but are found to vary with climate food and cultivation.

In this manner the number of animals of the cow kind which naturalists have extended to eight or ten sorts are reduced to two and as the utmost deference is paid to the opinion of Mr Buffon in this particular I have taken him for my guide. Nevertheless there is an animal of the cow kind which neither he nor any other naturalist that I know of has hitherto described yet which makes a very distinct class and may be added as a third species.

This animal was shown some years ago in London and seemed to unite many of the characteristics of the cow and the hog having the head the horns and the tail of the former with the bristles the colour and the grunting of the latter. It was about the size of an ass but broader and thicker the colour resembling that of a hog and the hair bristly as in that animal. The hair upon the body was thin as in the hog and a row of bristles ran along the spine rather shorter and softer than in the hog kind. The head was rather larger than that of a cow the teeth were entirely resembling those of that animal and the tongue was rough in like manner. It fed upon hay and consequently its internal conformation must have resembled that of the cow kind more than the hog whose food is always chosen of a kind more succulent. The eyes were placed in the head as with the cow and were pretty nearly of the same colour the horns were black and flattish but bent rather backwards to the neck as in the goat kind the neck was short and thick.

and the back rather rising in the middle; it was cloven-footed, like the cow, without those hinder claws that are found in the hog kinds. But the greatest variety of all in this extraordinary creature, which was a female, was, that it had but two teats, and consequently, in that respect, resembled neither of the kinds to which, in other circumstances, it bore so strong a similitude. Whether this animal was a distinct kind, or a monster, I will not pretend to say. It was shown under the name of the bonasus, and it was said, by the person who showed it, to have come from India but no credit is to be given to interested ignorance, the person only wanted to make the animal appear as extraordinary as possible, and I believe would scarcely scruple a lie or two to increase that wonder in us, by which he found the means of living.

CHAP. III

OF ANIMALS OF THE SHEEP AND GOAT KIND.*

As no two animals are found entirely the same, so it is not to be expected that any two races of animals should exactly correspond in every particular. The goat and the sheep are apparently different in the form of their bodies, in their covering, and in their horns. They may, from hence, be considered as two different kinds, with regard to all common and domestic purposes. But if we come to examine them closer, and observe their internal conformation, no two animals can be more alike, their feet, their four stomachs,

* In the sheep kind the horns are hollow, wrinkled, perennial, bent backwards and outwards, into a circular or spiral form, and generally placed at the sides of the head, in the lower jaw there are eight front teeth, but none in the upper, there are no canine teeth in either. In the goat the horns are hollow, rough, compressed, and rise somewhat erect from the top of the head, and bend backwards, there are eight front teeth in the lower jaw, none in the upper, and no canine teeth in either, the chin is bearded.

their suck their appetites all are entirely the same and shew the similitude between them but what makes a much stronger connection is that they propagate with each other The buck gort is found to produce with the ewe an animal that in two or three generations returns to the sheep and seems to retain no marks of its ancient progenitor * The sheep and the gort therefore may be considered as belonging to one family and were the whole races reduced to one of each they would quickly replenish the earth with their kind

If we examine the sheep and gort internally we shall find as was said that their conformation is entirely the same nor is their structure very remote from that of the cow kind which they resemble in their hoofs and in their chewing the cud Indeed all ruminant animals are internally very much alike The goat the sheep or the deer exhibit to the eye of the anatomist the same parts in miniature which the cow or the bison exhibited in the great But the differences between those animals are nevertheless sufficiently apparent Nature has obviously marked the distinctions between the cow and the sheep kind by their form and size and they are also distinguished from those of the deer kind by never shedding the horns Indeed the form and figure of these animals if there were nothing else would seldom fail of guiding us to the kind and we might almost upon sight tell which belongs to the deer kind and which are to be degraded into that of the gort However the annually shedding the horns in the deer and the permanence in the sheep draws a pretty exact line between the kinds so that we may hold to this distinction only and define the sheep and gort kind as ruminant animals of a smaller size that never shed their horns

If we consider these harmless and useful animals in one point of view we shall find that both have been long reclaimed and brought into a state of domestic servitude Both seem to require protection from man and are in some measure pleased with his society The sheep indeed is the more serviceable creature of the two but the goat has more sensibility and attachment The attending

upon both was once the employment of the wisest and the best of men ; and those have been ever supposed the happiest times in which these harmless creatures were considered as the chief objects of human attention In the earliest ages, the goat seemed rather the greater favourite ; and, indeed, it continues such, in some countries, to this day among the poor. However, the sheep has long since become the principal object of human care ; while the goat is disregarded by the generality of mankind, or become the possession only of the lowest of the people The sheep, therefore, and its varieties, may be considered first, and the goat, with all those of its kind, will then properly follow

THE SHEEP.

THOSE animals that take refuge under the protection of man, in a few generations become indolent and helpless Having lost the habit of self-defence, they seem to lose also the instincts of nature. The sheep, in its present domestic state, is, of all animals, the most defenceless and inoffensive With its liberty, it seems to have been deprived of its swiftness and cunning, and what in the ass might rather be called patience, in the sheep appears to be stupidity With no one quality to fit it for self-preservation, it makes vain efforts at all Without swiftness, it endeavours to fly, and without strength, sometimes offers to oppose But these feeble attempts rather incite than repress the insults of every enemy ; and the dog follows the flock with greater delight upon seeing them fly, and attacks them with more fierceness upon their unsupported attempts at resistance. Indeed, they run together in flocks rather with the hopes of losing their single danger in the crowd, than of uniting to repress the attack by numbers The sheep, therefore, were it exposed in its present state to struggle with its natural enemies of the forest, would soon be extirpated. Loaded with a heavy fleece, deprived of the defence of its horns, and rendered heavy, slow, and feeble, it can have no other safety than what it finds from man This animal is now, therefore, obliged to rely solely upon that

art for protection to which it originally owes its degradation

But we are not to impute to nature the formation of an animal so utterly unprovided against its enemies and so unfit for defence. The moufflon which is the sheep in a savage state is a bold fleet creature able to escape from the greater animals by its swiftness or to oppose the smaller kinds with the arms it has received from nature. It is by human art alone that the sheep has become the tardy defenceless creature we find it. Every race of quadrupeds might easily be corrupted by the same allurements by which the sheep has been thus debilitated and depressed. While undisturbed and properly supplied none are found to set any bounds to their appetite. They all pursue their food while able and continue to graze till they often die of disorders occasioned by too much fatness. But it is very different with them in a state of nature. they are in the forest surrounded by dangers and alarmed with unceasing hostilities. they are pursued every hour from one tract of country to another and spend a great part of their time in attempts to avoid their enemies. Thus constantly exercised and continually practising all the arts of defence and escape the animal at once preserves its life and native independence together with its swiftness and the slender agility of its form.

The sheep in its servile state seems to be divested of all inclinations of its own and of all animals it appears the most stupid. Every quadruped has a peculiar turn of countenance a physiognomy if we may so call it that generally marks its nature. The sheep seems to have none of those traits that betoken either courage or cunning. its large eyes separated from each other its ears sticking out on each side and its narrow nostrils all testify the extreme simplicity of this creature and the position of its horns also shew that nature designed the sheep rather for flight than combat. It appears a large mass of flesh supported upon four small straight legs ill fitted for carrying such a burden. its motions are awkward it is easily fatigued and often sinks under the weight of its own corpulency. In proportion as these marks of human transformation are more numerous the animal becomes more helpless and stupid.

Those which live upon a more fertile pasture, and grow fat, become entirely feeble; those that want horns are found more dull and heavy than the rest;* those whose fleeces are longest and finest are most subject to a variety of disorders; and, in short, whatever changes have been wrought in this animal by the industry of man are entirely calculated for human advantage, and not for that of the creature itself. It might require a succession of ages before the sheep could be restored to its primitive state of activity, so as to become a match for its pursuers of the forest.

The goat, which it resembles in so many other respects, is much its superior. The one has its particular attachment, sees danger, and generally contrives to escape it; but the other is timid without a cause, and secure when real danger approaches. Nor is the sheep, when bred up tame in the house, and familiarized with its keepers, less obstinately absurd from being dull and timid, it then acquires a degree of pert familiarity; but with its head, becomes mischievous, and shews itself every way unworthy of being singled out from the rest of the flock. Thus it seems rather formed for slavery than friendship; and framed more for the necessities than the amusements of mankind. There is but one instance in which the sheep shews any attachment to its keeper, and that is seen rather on the continent than among us in Great Britain. What I allude to is, their following the sound of the shepherd's pipe. Before I had seen them trained in this manner I had no conception of those descriptions in the old pastoral poets, of the shepherd leading his flock from one country to another. As I had been used only to see these harmless creatures driven before their keepers, I supposed that all the rest was but invention, but in many parts of the Alps, and even some provinces of France, the shepherd and his pipe are still continued with true antique simplicity. The flock is regularly penned every evening, to preserve them from the wolf, and the shepherd returns homeward at sun-set with his sheep following him, and seemingly pleased with the sound of the pipe, which is blown with a reed, and resembles the chanter of a bag-

* Daubenton upon the Sheep

pipe In this manner in those countries that still continue poor the Arcadian life is preserved in all its former purity, but in countries where a greater inequality of condition prevails, the shepherd is generally some poor wretch who attends a flock from which he is to derive no benefits and only guards those luxuries which he is not fated to share

It does not appear from early writers, that the sheep was bred in Britain and it was not till several ages after this animal was cultivated that the woollen manufacture was carried on among us * That valuable branch of business lay for a considerable time in foreign hands and we were obliged to import the cloth manufactured from our own materials There were notwithstanding many unwearied efforts among our kings to introduce and preserve the manufacture at home Henry the Second by a patent granted to the weavers in London directed that if any cloth was found made of a mixture of Spanish wool it should be burned by the mayor Such edicts at length although but slowly operated towards the establishing this trade among us The Flemings who at the revival of arts possessed the art of cloth working in a superior degree were invited to settle here and soon after foreign cloth was prohibited from being worn in England In the times of queen Elizabeth this manufacture received every encouragement and many of the inhabitants of the Netherlands being then forced by the tyranny of Spain to take refuge in this country they improved us in those arts in which we at present excel the rest of the world Every art however has its rise its meridian and its decline and it is supposed by many that the woollen manufacture has for some time been decaying amongst us The cloth now made is thought to be much worse than that of some years past being neither so firm nor fine neither so much courted abroad nor so serviceable at home

No country however produces such sheep as England either with larger fleeces or better adapted for the business of clothing Those of Spain indeed are finer and we generally require some of their wool to work up with our own but the weight of a Spanish fleece is no way

comparable to one of Lincoln or Warwickshire; and, in those counties it is no uncommon thing to give fifty guineas for a ram.

The sheep without horns are counted the best sort, because a great part of the animal's nourishment is supposed to go up into the horns * Sheep, like other ruminant animals, want the upper fore-teeth, but have eight in the lower jaw. two of these drop, and are replaced at two years old; four of them are replaced at three years old; and all at four The new teeth are easily known from the rest, by their freshness and whiteness. There are some breeds, however, in England, that never change their teeth at all, these the shepherds call the *leather-mouthed cattle*, and, as their teeth are thus long wearing, they are generally supposed to grow old a year or two before the rest † The sheep brings forth one or two at a time, and sometimes three or four The first lamb of an ewe is generally pot-bellied, short and thick, and of less value than those of a second or third production; the third being supposed the best of all. They bear their young five months; and, by being housed, they bring forth at any time of the year.

But this animal, in its domestic state, is too well known to require a detail of its peculiar habits, or of the arts which have been used to improve the breed Indeed, in the eye of an observer of nature, every art which tends to render the creature more helpless and useless to itself, may be considered rather as an injury than an improvement, and if we are to look for this animal in its noblest state, we must seek for it in the African desert, or the extensive plains of Siberia. Among the degenerate descendants of the wild sheep, there have been so many changes wrought, as entirely to disguise the kind, and often to mislead the observer The variety is so great, that scarcely any two countries have their sheep of the same kind; but there is found a manifest difference in all, either in the size, the covering, the shape, or the horns

The woolly sheep, ‡ as it is seen among us, is found only in Europe, and some of the temperate provinces of Asia. When transported into warmer countries, either

* Lisle's Husbandry, vol ii p 155

† Ibid

‡ Buffon, vol xviii p 168

into Florida or Guinea it loses its wool and assumes a covering fitted to the climate, becoming hairy and rough it there also loses its fertility and its flesh no longer has the same flavour. In the same manner in the very cold countries it seems equally helpless and a stranger it still requires the unceasing attention of mankind for its preservation and although it is found to subsist as well in Greenland as in Guinea * yet it seems a natural inhabitant of neither.

Of the domestic kinds to be found in the different parts of the world besides our own which is common in Europe the first variety is to be seen in Iceland Muscovy and the coldest climates of the north. This which may be called the Iceland sheep resembles our breed in the form of the body and the tail but differs in a very extraordinary manner in the number of the horns being generally found to have four and sometimes even eight growing from different parts of the forehead. These are large and formidable and the animal seems thus fitted by nature for a state of war however it is of the nature of the rest of its kind being mild gentle and timid. Its wool is very different also from that of the common sheep being long smooth and hairy. Its colour is of a dark brown and under its outward coat of hair it has an internal covering that rather resembles fur than wool being fine short, and soft.

The second variety to be found in this animal is that of the broad tailed sheep so common in Tartary Arabia Persia Barbary Syria and Egypt. This sheep is only remarkable for its large and heavy tail which is often found to weigh from twenty to thirty pounds. It sometimes grows a foot broad and is obliged to be supported by a small kind of board that goes upon wheels. This tail is not covered underneath with wool like the upper part but is bare and the natives who consider it as a very great delicacy are very careful in attending and preserving it from injury. Mr Buffon supposes that the fat which fills into the caul in our sheep goes in these to furnish the tail and that the rest of the body is from thence deprived of fat in proportion. With regard to their fleeces in the temperate climates they are as in our

own breed, soft and woolly, but in the warmer latitudes, they are hairy. yet in both they preserve the enormous size of their tails.

The third observable variety is that of the sheep called *strepsicheros*. This animal is a native of the islands of the Archipelago, and only differs from our sheep, in having straight horns, surrounded with a spiral furrow.

The last variety is that of the Gumea sheep, which is generally found in all the tropical climates, both of Africa and the East Indies. They are of a large size, with a rough hairy skin, short horns, and ears hanging down, with a kind of dewlap under the chin. They differ greatly in form from the rest, and might be considered as animals of another kind, were they not known to breed with other sheep. These, of all the domestic kinds, seem to approach the nearest to the state of nature. They are larger, stronger, and swifter, than the common race; and, consequently, better fitted for a precarious forest life. However, they seem to rely, like the rest, on man for support; being entirely of a domestic nature, and subsisting only in the warmer climates.

Such are the varieties of this animal, which have been reduced into a state of domestic servitude. These are all capable of producing among each other; all the peculiarities of their form have been made by climate and human cultivation, and none of them seem sufficiently independent to live in a state of savage nature. They are, therefore, to be considered as a degenerate race, formed by the hand of man, and propagated merely for his benefit. At the same time, while man thus cultivates the domestic kinds, he drives away and destroys the savage race, which are less beneficial, and more headstrong. These, therefore, are to be found in but a very small number, in the most uncultivated countries, where they have been able to subsist by their native swiftness and strength. It is in the more uncultivated parts of Greece, Sardinia, Corsica, and particularly in the deserts of Tartary, that the moufflon is to be found, that bears all the marks of being the primitive race, and that has been actually known to breed with the domestic animal.

The moufflon, or musmon, though covered with hair, bears a stronger similitude to the ram, than to any other

animal like the ram it has the eyes placed near the horns and its ears are shorter than those of the goat it also resembles the ram in its horns and in all the particular contours of its form The horns also are alike they are of a yellow colour they have three sides, as in the ram and bend backwards in the same manner behind the ears, the muzzle and the inside of the ears are of a whitish colour tinged with yellow the other parts of the face are of a brownish grey The general colour of the hair over the body is of a brown approaching to that of the red deer The inside of the thighs and the belly are of a white tinged with yellow The form upon the whole seems more made for agility and strength than that of the common sheep and the mousson is actually found to live in a savage state and maintain itself either by force or swiftness against all the animals that live by rapine Such is its extreme speed that many have been inclined rather to rank it among the deer kind than the sheep But in this they are deceived as the musmon has a mark that entirely distinguishes it from that species being known never to shed its horns In some these are seen to grow to a surprising size many of them measuring in their convolutions above two ells long They are of a yellow colour as was said but the older the animal grows the darker the horns become with these they often maintain very furious battles between each other and sometimes they are found broken off in such a manner that the small animals of the forest creep into the cavity for shelter * When the musmon is seen standing on the plain his fore legs are always strait while his hinder legs seem bent under him but in cases of more active necessity this seeming deformity is removed and he moves with great swiftness and agility The female very much resembles the male of this species but that she is less and her horns also are never seen to grow to that prodigious size they are of in the wild ram Such is the sheep in its savage state a bold noble and even beautiful animal but it is not the most beautiful creatures that are always found most useful to man Human industry has therefore destroyed its grace, to improve its utility

* Gmelin is quoted by Buffon

THE GOAT,

AND ITS NUMEROUS VARIETIES

THERE are some domestic animals that seem as auxiliaries to the more useful sorts ; and that, by ceasing to be the first, are considered as nothing We have seen the services of the ass slighted, because inferior to those of the horse ; and, in the same manner, those of the goat are held cheap, because the sheep so far exceeds it Were the horse or the sheep removed from nature, the inferior kinds would then be invaluable ; and the same arts would probably be bestowed in perfecting them kinds, that the higher order of animals have experienced But in their present neglected state, they vary but little from the wild animals of the same kind man has left them their primitive habits and forms ; and the less they owe to his assiduity, the more they receive from nature

The goat seems, in every respect, more fitted for a life of savage liberty than the sheep * It is naturally more lively, and more possessed with animal instinct It easily attaches itself to man, and seems sensible of his caresses. It is also stronger and swifter, more courageous, and more playful, lively, capricious, and vagrant. it is not easily confined to its flock, but chooses its own pastures, and loves to stray remote from the rest It chiefly delights in climbing precipices, in going to the very edge of danger ; it is often seen suspended upon an eminence hanging over the sea, upon a very little base, and even sleeps there in security Nature has, in some measure, fitted it for traversing these declivities with ease, the hoof is hollow underneath, with sharp edges, so that it walks as securely on the ridge of a house, as on the level ground It is a hardy animal, and very easily sustained, for which reason it is chiefly the property of the poor, who have no pastures with which to supply it Happily, however, it seems better pleased with the neglected wild, than the cultivated fields of art ; it chooses the heathy mountain, or the shrubby rock ; its favourite food is the tops of boughs, or the tender bark of young trees, it seems less afraid of immoderate heat, and bears the warm climates better than

the sheep it sleeps exposed to the sun and seems to enjoy its warmest fervors neither is it terrified at the storm or incommoded by the rain, immoderate cold alone seems to afflict it and is said to produce a vertigo with which this animal is sometimes incommoded. The inconstancy of its nature is perceivable in the irregularity of its gait it goes forward stops runs approaches flies merely from caprice and with no other seeming reason than the extreme vivacity of its disposition.

There are proofs of this animal's being naturally the friend of man and that the goat seldom resumes its primitive wildness when once reduced into a state of servitude. In the year 1698 an English vessel happening to touch at the island of Bonavista, two negroes came and offered the sailors as many goats as they chose to take away. Upon the captain's expressing his astonishment at this offer the negroes assured him that there were but twelve persons in the island and that the goats were multiplied in such a manner as even to become a nuisance they added that instead of giving any trouble to catch them they followed the few inhabitants that were left with a sort of obstinacy, and rather became importunate with their tameness.

The goat produces but two at a time and three at the most. But in the warmer climates although the animal degenerates and grows less yet it becomes more fruitful being generally found to bring forth three four and five at a single delivery. The buck is capable of propagating at the age of one year and the female at seven months how ever the fruits of this premature generation are weak and defective and their best breeding time is generally delayed till the age of two years or eighteen months at least. One buck is sufficient for a hundred and fifty goats his appetites are excessive but this ardour brings on a speedy decay so that he is enervated in four years at most and even becomes old before he reaches his seventh year. The goat like the sheep continues five months with young and in some places bears twice a year.

The milk of the goat is sweet nourishing and medicinal not so apt to curdle upon the stomach as that of the cow and therefore preferable to those whose digestion is but weak. The peculiarity of this animal's food gives

the milk a flavour different from that either of the cow or the sheep, for as it generally feeds upon shrubby pastures, and heathy mountains, there is an agreeable mildness in the taste, very pleasing to such as are fond of that aliment. In several parts of Ireland, and the highlands of Scotland, the goat makes the chief possession of the inhabitants. On those mountains, where no other useful animal could find subsistence, the goat continues to glean a sufficient living, and supplies the hardy natives with what they consider as varied luxury. They lie upon beds made of their skins, which are soft, clean, and wholesome; they live upon their milk, with oat-bread; they convert a part of it into butter, and some into cheese the flesh, indeed, they seldom taste of, as it is a delicacy which they find too expensive; however, the kid is considered, even by the city epicure, as a great rarity; and the flesh of the goat, when properly prepared, is ranked by some as no way inferior to venison. In this manner, even in the wildest solitudes, the poor find comforts of which the rich do not think it worth their while to dispossess them in these mountainous retreats, where the landscape presents only a scene of rocks, heaths, and shrubs, that speak the wretchedness of the soil, these simple people have their feasts and their pleasures; their faithful flock of goats attends them to these awful solitudes, and furnishes them with all the necessaries of life; while their remote situation happily keeps them ignorant of greater luxury.

As these animals are apt to stray from the flock, no man can attend above fifty of them at a time. They are fattened in the same manner as sheep; but, taking every precaution, their flesh is never so good or so sweet, in our climate, as that of mutton. It is otherwise between the tropics. The mutton there becomes flabby and lean, while the flesh of the goat rather seems to improve, and in some places the latter is cultivated in preference to the former. We, therefore, find this animal in almost every part of the world, as it seems fitted for the necessities of man in both extremes. Towards the north, where the pasture is coarse and barren, the goat is fitted to find a scanty subsistence; between the tropics, where the heat is excessive, the goat is fitted to bear the climate, and its flesh is found to improve.

One of the most remarkable varieties we find in the goat is in that of Nilotia. The Nilotian goat or as Mr Buffon calls it the goat of *Angora* has the ears longer than ours and broader in proportion. The male has horns of about the same length with the goat of Europe but black and turned very differently going out horizontally on each side of the head and twisted round in the manner of a cork screw. The horns of the female are shorter and encircle the eye somewhat like those of the ram. They are of a dazzling white colour and in all the hair is very long thick fine and glossy which indeed is the case with almost all the animals of Syria. There are a great number of these animals about Angora where the inhabitants drive a trade with their hair which is sold either raw or manufactured into all parts of Europe. Nothing can exceed the beauty of the stuffs which are made from the hair of almost all the animals of that country. These are well known among us by the name of *camlet*.

A second variety is the Assyrian goat of Gesner which is somewhat larger than ours with ears almost hanging down to the ground and broad in proportion *. The horns on the contrary are not above two inches and a half long black and bending a little backwards. The hair is of a fox colour and under the throat there are two excrescences like the gills of a cock. These animals are chiefly kept round Aleppo for the sake of their milk. They are driven through the streets and their milk is sold to the inhabitants as they pass along.

In the third variety may be reckoned the little goat of Africa which is of the size of a kid but the hair is as long as that of the ordinary breed. The horns which do not exceed the length of a man's finger are thick and bend downwards so close to the head that they almost enter the skin.

There is an animal of this kind at the Cape of Good Hope called the *blue goat* which may be ranked as the fourth variety. It is in shape like the domestic but much larger being nearly of the size of a stag. Its hair is very short and of a delightful blue but it loses a great deal of

its beauty when the animal is dead. It has a very long beard; but the horns are not so long in proportion as in other goats, being turned spirally, in the manner of a cork-screw. It has very long legs, but well proportioned; and the flesh is very well tasted, but lean. For this reason, in that plentiful country, it is chiefly killed upon account of its skin. It is a very shy animal, and seldom comes near the Dutch settlements, but they are found in great abundance in the more uncultivated parts of the country. Besides these, they are found in this extensive region of various colours, and many of them are spotted beautifully, with red, white, and brown.*

In fine, the Juda goat resembles ours in most parts, except in size, it being much smaller. This animal is common in Guinea, Angola, and all along the coasts of Africa; it is not much larger than a hare, but it is extremely fat, and its flesh admirably tasted. It is in that country universally preferred to mutton.

These animals seem all of one kind, with very trifling distinctions between them. It is true that they differ in some respects, such as having neither the same colour, hair, ears, or horns. But it ought to be considered as a rule in natural history, that neither the horns, the colour, the fineness or the length of the hair, or the position of the ears, are to be considered as making an actual distinction in the kinds. These are accidental varieties, produced by climate and food, which are known to change even in the same animal, and give it a seeming difference of form. When we see the shapes, the inclinations, and the internal conformation, of seemingly different creatures nearly the same; and, above all, when we see them producing among each other, we then have no hesitation in pronouncing the species, and asserting that these are of the goat kind, with which they are so materially connected.

But although these are evidently known to belong to the goat kind, there are others nearly resembling the goat, of whose kindred we cannot be equally certain. These are such as, being found in a state of nature, have not as yet been sufficiently subjected to human observation. Hence

* This species is now known to be of the antelope tribe, and is, by all modern zoological writers, called the blue antelope.

it is impossible to determine with precision to which class they belong, whether they be animals of a particular kind, or merely the goat in its state of savage freedom. Were there but one of these wild animals, the inquiry would soon be ended and we might readily allow it for the parent stock but in the present case there are two kinds that have almost equal pretensions to this honour and the claims of which it has been found difficult to determine. The animals in question are the chamois and the ibex. These both bear very near approaches to the goat in figure, have horns that never shed and at the same time are more different from each other than from the animal in question. From which of these two sources our domestic goat is derived is not easy to settle. Instead therefore of entering into the discussion I will content myself with the result of Mr Buffon's inquiries. He is of opinion that the ibex is the principal source that our domestic goat is the immediate descendant and that the chamois is but a variety from that stock a sort of collateral branch of the same family. His principal reason for giving the preference to the ibex is its having a more masculine figure large horns and a large beard whereas the chamois wants these marks of primitive strength and wildness. He supposes therefore in their original savage state that our goat has taken after the male of the parent stock and the chamois after the female and that this has produced a variety in these animals even before they underwent human cultivation.

However this be the two animals in question seem both well fitted for their precarious life being extremely swift and capable of running with ease along the ledges of precipices where even the wolf or the fox though instigated by hunger dares not pursue them. They are both natives of the Alps the Pyrenees and the mountains of Greece there they propagate in vast numbers and continue to exist in spite of the hunter and every beast of prey that is found incessantly to pursue them.

The ibex resembles the goat in the shape of its body, but differs in the horns which are much larger. They are bent backward full of knots and it is generally asserted that there is a knot added every year. There are some of these found if we may believe Bellonius at least two yards long.

The ibex has a large black beard, is of a brown colour, with a thick warm coat of hair. There is a streak of black runs along the top of the back; and the belly and back of the thighs are of a fawn colour.

The chamois, though a wild animal, is very easily tamed, and docile, and to be found only in rocky, and mountainous places. It is about the size of a domestic goat, and resembles one in many respects. It is most agreeably lively, and active beyond expression. The chamois' hair is short, like that of the doe, in spring, it is of an ash colour; in autumn, a dun colour, inclining to black; and in winter, of a blackish brown. This animal is found in great plenty in the mountains of Dauphiny, of Piedmont, Savoy, Switzerland, and Germany. They are peaceful, gentle creatures, and live in society with each other. They are found in flocks of from four to fourscore, and even a hundred, dispersed upon the crags of the mountains. The large males are seen feeding detached from the rest, except in rutting time, when they approach the females, and drive away the young. The time of their coupling is from the beginning of October to the end of November, and they bring forth in March and April. The young keeps with the dam about five months, and sometimes longer, if the hunters and the wolves do not separate them. It is asserted that they live between twenty and thirty years. Their flesh is good to eat, and they are found to have ten or twelve pounds of suet, which far surpasses that of the goat in hardness and goodness. The chamois has scarcely any cry, as most animals are known to have, if it has any, it is a kind of feeble bleat, by which the parent calls its young. But in cases of danger, and when it is to warn the rest of the flock, it uses a hissing noise, which is heard at a great distance. For it is to be observed, that this creature is extremely vigilant, and has an eye the quickest and most piercing in nature. Its smell also is not less distinguishing. When it sees its enemy distinctly, it stops for a moment, and then, if the person be near, in an instant after it flies off. In the same manner, by its smell, it can discover a man at half a league distance, and gives the earliest notice. Upon any alarm, therefore, or any apprehension of danger, the chamois begins his

hissing note with such force that the rocks and the forests re-echo to the sound. The first hiss continues as long as the time of one inspiration. In the beginning it is very sharp and deeper towards the close. The animal having after this first alarm reposed a moment again looks round and perceiving the reality of its fears continues to hiss by intervals until it has spread the alarm to a very great distance. During this time it seems in the most violent agitation it strikes the ground with its fore foot, and sometimes with both it bounds from rock to rock it turns and looks round it runs to the edge of the precipice and still perceiving the enemy flies with all its speed. The hissing of the male is much louder and sharper than that of the female it is performed through the nose and is properly no more than a very strong breath driven violently through a small aperture. The chamois feeds upon the best herbage and chooses the most delicate parts of the plants the flower and the tender buds. It is not less delicate with regard to several aromatic herbs which grow upon the sides of the mountains. It drinks but very little while it feeds upon the succulent herbage and chews the cud in the intervals of feeding. This animal is greatly admired for the beauty of its eyes which are round and sparkling and which mark the warmth of its constitution. Its head is furnished with two small horns of about half a foot long of a beautiful black and rising from the forehead almost betwixt the eyes. These contrary to what they are found in other animals instead of going backwards or sideways jet out forward and bend a little at their extremities backward in a small circle and end in a very sharp point. The ears are placed in a very elegant manner near the horns and there are two stripes of black on each side of the face the rest being of a whitish yellow which never changes. The horn of this animal is often used as the head of a cane. Those of the female are less and not so much bent and some farmers are seen to bleed cattle with them. These animals are so much incommoded by heat that they are never found in summer except in the caverns of rocks amidst fragments of unmelted ice under the shade of high and spreading trees or of rough and hanging precipices that face the north and which keep off entirely the rays of the sun. They go to pasture both

morning and evening, and seldom during the heat of the day. They run along the rocks with great ease and seeming indifference, and leap from one to another, so that no dogs are able to pursue them. There is nothing more extraordinary than to see them climbing and descending precipices, that to all other quadrupeds are inaccessible. They always mount or descend in an oblique direction; and throw themselves down a rock of thirty feet, and light with great security upon some excrescence or fragment, on the side of the precipice, which is just large enough to place their feet upon; they strike the rock, however, in their descent, with their feet, three or four times, to stop the velocity of their motion, and, when they have got upon their base below, they at once seem fixed and secure. In fact, to see them jump in this manner, they seem rather to have wings than legs. Some, indeed, pretend to say, that they use their horns for climbing, but this wants confirmation. Certain it is that their legs alone are formed for this arduous employment, the hinder being rather longer than the former, and bending in such a manner, that when they descend upon them, they break the force of the fall. It is also asserted, that when they feed, one of them always stands as centinel, but how far this may be true is questionable. For certain, while they feed, there are some of them that keep continually gazing round the rest; but this is practised among all gregarious animals, so that when they see any danger, they warn the rest of the herd of its approach. During the rigours of winter, the chamois sleeps in the thicker forests, and feeds upon the shrubs and the buds of the pine-tree. It sometimes turns up the snow with its foot to look for herbage, and, where it is green, makes a delicious repast. The more craggy and uneven the forest, the more this animal is pleased with the abode, which thus adds to its security. The hunting the chamois is very laborious, and extremely difficult. The most usual way is to hide behind the clefts of the rocks, and shoot them. This, however, must be done with great precaution, the sportsman must creep for a vast way upon his belly in silence, and take also the advantage of the wind, which if it blow from him they would instantly perceive. When arrived at a proper distance, he then advances his piece, which

is to be rifle barrelled and to carry one ball and tries his fortune among them. Some also pursue this animal as they do the stag by placing proper persons at all the passages of a glade or valley and then sending in others to rouse the game. Dogs are quite useless in this chase as they rather alarm than overtake. Nor is it without danger even to the men for it often happens that when the animal finds itself overpressed it drives at the hunter with its head and often tumbles him down the neighbouring precipice. This animal cannot go upon ice when smooth but if there be the least inequalities on its surface it then bounds along in security and quickly evades all pursuit.

The skin of the chamois was once famous when tanned for its softness and warmth at present however since the art of tanning has been brought to greater perfection the leather called *shammoy* is made also from those of the true goat the sheep and the deer. Many medicinal virtues also were said to reside in the blood fat gall and the concretion sometimes found in the stomach of this animal called the *German bezoar*. The fat mixed with milk was said to be good in ulcers of the lungs. The gall was said to be useful in strengthening the sight the stone which is generally about the size of a walnut and blackish was formerly in great request for having the same virtues with oriental bezoar. However in the present enlightened state of physic all these medicines are quite out of repute and although we have the names of several medicines procurable from quadrupeds yet except the musk or hartshorn alone I know of none in any degree of reputation. It is true the fat the urine the bark and even the dung of various animals may be found efficacious where better remedies are not to be had but they are far surpassed by many at present in use whose operations we know and whose virtues are confirmed by repeated experience.

Such are the quadrupeds that more peculiarly belong to the goat kind. Each of these in all probability can engender and breed with the other and were the whole race extinguished except any two these would be sufficient to replenish the world and continue the kind. Nature however proceeds in her variations by slow and insensible

degrees, and scarcely draws a firm distinguished line between any two neighbouring races of animals whatsoever. Thus it is hard to discover where the sheep ends, and the goat begins, and we shall find it still harder to fix precisely the boundaries between the goat kind and the deer. In all transitions from one kind to the other, there are to be found a middle race of animals, that seem to partake of the nature of both, and that can precisely be referred to neither. That race of quadrupeds, called the *gazelles*, are of this kind, they are properly neither goat nor deer, and yet they have many of the marks of both; they make the shade between these two kinds, and fill up the chasm in nature.

THE GAZELLES'

THE Gazelles, of which there are several kinds, can, with propriety, be referred neither to the goat or the deer, and yet they partake of both natures. Like the goat, they have hollow horns that never fall, which is otherwise in the deer. They have a gall-bladder which is found in the goat, and not in the deer; and, like that animal, they feed rather upon shrubs than grassy pastures. On the other hand, they resemble the roebuck in size and delicacy of form, they have deep pits under the eyes like that animal, they resemble the roebuck in the colour and nature of their hair, they resemble him in the bunches upon their legs, which only differ in being upon the fore-legs in these, and on the hind legs in the other. They seem, therefore, to be of a middle nature between these two kinds; or, to speak with greater truth and precision, they form a distinct kind by themselves.

The distinguishing marks of this tribe of animals, by which they differ both from the goat and the deer are these, their horns are made differently, being annulated or ringed round, at the same time that there are longitudinal depressions running from the bottom to the point. They have bunches of hair upon their fore-legs, they have a streak of black, red, or brown, running along the lower part of their sides, and three streaks of whitish hair in the internal side of the ear. These are characters that none of them are without;

besides these there are others which in general they are found to have and which are more obvious to the beholder. Of all animals in the world the gazelle has the most beautiful eye extremely brilliant and yet so meek that all the eastern poets compare the eyes of their mistresses to those of this animal. A gazelle eyed beauty is considered as the highest compliment that a lover can pay and indeed the Greeks themselves thought it no indecent piece of flattery to resemble the eyes of a beautiful woman to those of a cow. The gazelle for the most part is more delicately and finely limbed than even the roebuck its hair is as short but finer and more glossy. Its hinder legs are longer than those before as in the hare which gives it greater security in ascending or descending steep places. Their swiftness is equal if not superior to that of the roe, but as the latter bounds forward so these run along in an even uninterrupted course. Most of them are brown upon the back white under the belly with a black stripe separating those colours between. Their tail is of various lengths but in all covered with pretty long hair and their ears are beautiful well placed and terminating in a point. They all have a cloven hoof like the sheep they all have permanent horns and the female has them smaller than the male.

Of these animals Mr Buffon makes twelve varieties, which however is much fewer than what other naturalists have made them. The first is the *gazelle* properly so called which is of the size of the roebuck and very much resembling it in all the proportions of its body but entirely differing as was said in the nature and fashion of the horns which are black and hollow like those of the ram or the goat and never fall. The second he calls the *leisel* which is rather less than the former its eyes also seem larger and its horns instead of being round are flattened on the sides as well in the male as the female. The third he calls the *corin* which very much resembles the two former but that it is still less than either. Its horns also are smaller in proportion smoother than those of the other two and the annular prominences belonging to the kind are scarcely discernible and may rather be called wrinkles than prominences. Some of these animals are often seen streaked like the tiger. These three are sup

posed to be of the same species. The fourth he calls the *zanan*, the horns only of which he has seen; which, from their size, and the description of travellers, he supposes to belong to a larger kind of the gazelle, found in India and Persia, under that denomination.

The fifth he calls the *loba*, and the sixth the *lob*, these two differ from each other only in size, the former being much larger than the latter. The muzzle of these animals is much longer than those of the ordinary gazelle, the head is differently shaped, and they have no depressions under the eyes. The seventh he calls after its Egyptian name, the *algazel*, which is shaped pretty much like the ordinary gazelle, except that the horns are much longer, being generally three feet from the point to the insertion; whereas, in the common gazelle, they are not above a foot, they are smaller also, and straighter, till near the extremities, when they turn short, with a very sharp flexure; they are black and smooth, and the annular prominences are scarcely observable. The eighth is called the *pasan*, or, by some, the *bezoar goat*, which greatly resembles the former, except a small variety in their horns; and also with this difference, that as the *algazel* feeds upon the plains, this is only found in the mountains. They are both inhabitants of the same countries and climate; being found in Egypt, Arabia, and Persia. This last is the animal famous for that concretion in the intestines or stomach, called the *oriental bezoar*, which was once in such repute all over the world for its medicinal virtues. The word *bezoar* is supposed to take its name either from the *pazan* or *pazar*, which is the animal that produces it, or from a word in the Arabic language, which signifies *antidote* or *counter-poison*. It is a stone of a glazed blackish colour, found in the stomach or the intestines of some animal, and brought over to us from the East-Indies. Like all other animal concretions, it is found to have a kind of nucleus, or hard substance within, upon which the external coatings were formed; for, upon being sawed through, it is seen to have layer over layer, as in an onion. This nucleus is of various kinds, sometimes the buds of a shrub, sometimes a piece of stone, and sometimes a malacite. This stone is from the size of an acorn to that of a pigeon's egg, the larger the stone, the more valuable it is held,

its price increasing like that of a diamond. There was a time when a stone of four ounces sold in Europe for above two hundred pounds but at present the price is greatly fallen and they are in very little esteem. The bezoar is of various colours sometimes of a blood colour sometimes of a pale yellow and of all the shades between these two. It is generally glossy smooth and has a fragrant smell like that of ambergris probably arising from the aromatic vegetables upon which the animal that produces it feeds. It has been given in vertigos epilepsies palpitations of the heart colic and jaundice and in those places where the dearthness and not the value of medicines is consulted in almost every disorder incident to man. In all perhaps it is equally efficacious acting only as an absorbent powder and possessing virtues equal to common chalk or erics claus. Judicious physicians have therefore discarded it and this celebrated medicine is now chiefly consumed in countries where the knowledge of nature has been but little advanced. When this medicine was in its highest reputation many arts were used to adulterate it and many countries endeavoured to find out a bezoar of their own. Thus we had occidental bezoar brought from America German bezoar which has been mentioned before cow bezoar and monkey bezoar. In fact there is scarcely an animal except of the carnivorous kinds that does not produce some of these concretions in the stomach intestines kidneys bladder and even in the heart. To these ignorance may impute virtues that they do not possess experience has found but few cures performed by their efficacy but it is well known that they often prove fatal to the animal that bears them. These concretions are generally found in cows by their practice of licking off their hair which gathers in the stomach into the shape of a ball requires a surprising degree of hardness and sometimes a polish like leather. They are often as large as a goose egg and when become too large to pass block up the passage of the food and the animal dies. The substance of these balls however is different from the bezoar mentioned above being rather a concretion of hair than of stone. There is a bezoar found in the gall bladder of a boar and thence called *hog bezoar* in very great esteem but perhaps with as little justice as any of the former. In

short, as we have already observed, there is scarcely an animal, or scarcely a part of their bodies, in which concretions are not formed; and it is more than probable, as Mr. Buffon justly remarks, that the bezoar so much in use formerly, was not the production of the pazar, or any one animal only, but that of the whole gazelle kind, who feeding upon odoriferous herbs and plants, gave this admirable fragrance to the accidental concretions which they were found to produce. As this medicine, however, is but little used at present, our curiosity is much abated as to the cause of its formation. To return, therefore, to the varieties in the gazelle tribe, the ninth is called the *ranguet*, and is a native of Senegal. This differs somewhat in shape and colour from the rest; but particularly in the shape of its horns, which are straight to near the points, where they crook forward, pretty much in the same manner as in the chamois they crook backward. The tenth variety of the gazelle is the *antelope*, so well known to the English, who have given it the name. This animal is of the size of a roe-buck, and resembles the gazelle in many particulars, but differs in others: it has deeper eye-pits than the former, the horns are formed differently also, being about sixteen inches long, almost touching each other at the bottom, and spreading as they rise, so as at their tips to be sixteen inches asunder. They have the annular prominences of their kind, but not so distinguishable as in the gazelle: however, they have a double flexure, which is very remarkable, and serves to distinguish them from all others of their kind. At the root they have a tuft of hair, which is longer than that of any part of the body. Like others of the same kind, the antelope is brown on the back, and white under the belly, but these colours are not separated by the black streak which is to be found in all the rest of the gazelle kinds. There are different sorts of this animal, some with larger horns than others, and others with less. The one which makes the eleventh variety in the gazelle kind, Mr. Buffon calls the *ludme*, which has very long horns, and the other, which is the twelfth and last, he calls the *Indian antelope*, the horns of which are very small.

To these may be added three or four varieties more, which it is not easy to tell whether to refer to the goat or the gazelle, as they equally resemble both. The first of these

is the *bubalus* an animal that seems to partake of the mixed natures of the cow the goat and the deer. It resembles the stag in the size and the figure of its body and particularly in the shape of its legs. But it has permanent horns like the goat and made entirely like those of the gazelle kind. It also resembles that animal in its way of living; however, it differs in the make of its head being exactly like the cow in the length of its muzzle and in the disposition of the bones of its skull from which similitude it has taken its name. This animal has a narrow long head the eyes are placed very high the forehead short and narrow the horns permanent about a foot long black thick annulated and the rings of the gazelle kind remarkably large its shoulders are very high and it has a kind of bunch on them that terminates at the neck the tail is about a foot long and tufted with hair at the extremity. The hair of this animal is remarkable in being thicker at the middle than at the root in all other quadrupeds except the elk and thus the hair tapers off from the bottom to the point but in these each hair seems to swell in the middle like a nine pin. The *bubalus* also resembles the elk in size and the colour of its skin, but these are the only similitudes between them as the one has a very large branching head of solid horns that are annually deciduous the other has black unbranching hollow horns that never fall. The *bubalus* is common enough in Barbary, and has often been called by the name of the *Barbary cow* from which animal it differs so widely. It partakes pretty much of the nature of the antelope like that having the hair short the hide black the ears pointed and the flesh good for food.

The second anomalous animal of the goat kind Mr Buffon calls the *condama*. It is supposed to be equal in size to the largest stag but with hollow horns like those of the goat kind and with varied flexures like those of the antelope. They are above three feet long and at their extremities about two feet asunder. All along the back there runs a white list which ends at the insertion of the tail another of the same colour crosses this at the bottom of the neck which it entirely surrounds there are two more of the same kind running round the body one behind the fore legs and the other running parallel to it before the hinder. The colour of the rest of the body is grayish except

the belly, which is white · it has also a long gray beard, and its legs, though long, are well proportioned

The third that may be mentioned, he calls the *gurba*. It resembles the gazelles in every particular, except in the colour of the belly, which, as we have seen, is white in them, but in this is of a deep brown Its horns also are not marked with annular prominences, but are smooth and polished It is also remarkable for white lists, on a brown ground, that are disposed along the animal's body, as if it were covered with harness. Like the former it is a native of Africa

The *African wild goat* of Grimmer is the fourth It is of a dark ash-colour; and in the middle of the head is a hairy tuft, standing upright; on both sides, between the eyes, and the nose, there are very deep cavities, greater than those of the other kinds, which contain a yellow oily liquor, coagulating into a black substance, that has a smell between musk and civet This being taken away, the liquor again runs out, and coagulates, as before These cavities have no communication with the eyes, and, consequently, this oozing substance can have nothing of the nature of tears

To this we may add the *chevrotin*, or little Guinea deer, which is the least of all cloven-footed quadrupeds, and perhaps the most beautiful, its legs, at the smallest part, are not much thicker than the shank of a tobacco-pipe; it is about seven inches high, and about twelve from the point of the nose to the insertion of the tail It is the most delicately shaped animal in the world, being completely formed like a stag in miniature, except that its horns, when it has any, are more of the gazelle kind, being hollow and annulated in the same manner It has two canine teeth in the upper jaw, in which respect it differs from all other animals of the goat or deer kind, and thus makes a species entirely distinct by itself This wonderful animal's colour is not less pleasing; the hair, which is short and glossy, being in some of a beautiful yellow, except on the neck and belly, which is white. They are natives of India, Guinea, and the warm climates between the tropics, and are found in great plenty But though they are amazingly swift for their size, yet the negroes often overtake them in the pursuit, and knock them down with their sticks. They may be easily tamed, and then they become familiar and pleasing, but they are of such

delicate constitutions that they can bear no climate but the hottest and they always perish with the rigours of ours when they are brought over. The male in Guinea has horns the female is without any as are all the kinds of this animal to be found either in Java or Ceylon where they chiefly abound *

Such is the list of the gazelles all which pretty nearly resemble the deer in form and delicacy of shape but have the horns hollow single and permanent like those of the goat. They properly fill up as has been already observed the interval between these two kinds of animals so that it is difficult to tell where the goat ends and the deer may be said to begin. If we compare the gazelles with each other we shall find but very slight distinctions between them. The turn or the magnitude of the horns the different spots on the skin or a difference of size in each are chiefly the marks by which their varieties are to be known but their way of living their nature and their peculiar swiftness all come under one description.

The gazelles are in general inhabitants of the warmer climates and contribute among other embellishments to add beauty to those forests that are for ever green. They are often seen feeding in herds on the sides of the mountains or in the shade of the woods and fly all together upon the smallest approaches of danger. They bound with such swiftness and are so very shy that dogs or men vainly attempt to pursue them. They traverse those precipices with ease and safety which to every quadruped else are quite impracticable nor can any animals but of the winged kind overtake them. Accordingly in all those countries where they are chiefly found they are pursued by falcons and this admirable manner of hunting makes

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upper jaw there are a pair of projecting tusks or canine teeth and it has no appendicular or false hoofs. In size it is smaller than a domestic cat and its general colour is a bright bay

one of the principal amusements of the upper ranks of people all over the East. The Arabians, Persians, and Turks, breed up for this purpose that kind of hawk called the *falcon gentle*, with which, when properly trained, they go forth on horseback among the forests and the mountains, the falcon perching upon the hand of the hunter. Their expedition is conducted with profound silence, their dogs are taught to hang behind; while the men, on the fleetest coursers, look round for the game. Whenever they spy a gazelle at the proper distance, they point the falcon to its object, and encourage it to pursue. The falcon, with the swiftness of an arrow, flies to the animal, that, knowing its danger, endeavours, but too late, to escape. The falcon soon coming up with its prey, fixes its talons, one into the animal's cheek, the other in its throat, and deeply wounds it. On the other hand, the gazelle attempts to escape, but is generally wounded too deeply to run far. The falcon clings with the utmost perseverance, nor ever leaves its prey till it falls; upon which the hunters from behind approaching, take up both, and reward the falcon with the blood of the spoil. They also teach the young ones, by applying them to the dead animal's throat, and accustoming them betimes to fix upon that particular part; for if it should happen that the falcon fixed upon any other part of the gazelle, either its back or its haunches, the animal would easily escape among the mountains, and the hunter would also lose his falcon.—They sometimes also hunt these animals with the ounce. This carnivorous and fierce creature being made tame and domestic, generally sits on horseback behind the hunter, and remains there with the utmost composure, until the gazelle is shewn, it is then that it exerts all its aits and fierceness, it does not at once fly at its prey, but approaches shyly, turning and winding about until it comes within the proper distance, when all at once it bounds upon the heedless animal, and instantly kills it, and sucks its blood. If, on the other hand, it misses its aim, it rests in its place, without attempting to pursue any farther, but seems ashamed of its own inability.

There is still another way of taking the gazelle, which seems not so certain nor so amusing as either of the former. A tame gazelle is bred up for this purpose, who is taught to join those of its kind, wherever it perceives

them. When the hunter therefore perceives a herd of these together he fixes a noose round the horns of the tame gazelle in such a manner that if the rest but touch it they are entangled and thus prepared, he sends his gazelle among the rest. The tame animal no sooner approaches but the males of the herd instantly rally forth to oppose him, and in butting with their horns are caught in the noose. In this both struggling for some time fall together to the ground, and at last the hunter coming up disengages the one and kills the other. Upon the whole however these animals whatever be the arts used to pursue them are very difficult to be taken. As they are continually subject to alarms from carnivorous beasts or from man they keep chiefly in the most solitary and inaccessible places and find their only protection from situations of the greatest danger.

CHAP. IV

OF THE MUSK ANIMAL

THE more we search into nature the more we shall find how little she is known and we shall more than once have occasion to find that protracted inquiry is more apt to teach us modesty than to produce information. Although the number and nature of quadrupeds at first glance seems very well known yet when we come to examine closer we find some with which we are very partially acquainted and others that are utterly unknown. There is scarcely a cabinet of the curious but what has the spoils of animals or the horns or the roofs of quadrupeds which do not come within former descriptions. There is scarcely a person whose trade is to dress or improve furs but knows several creatures by their skins which no naturalist has hitherto had notice of. But of all quadrupeds there is none so justly the reproach of natural historians as that which bears the musk. This perfume so well known to the elegant, and so very useful in the hands of the physician a medicine that has for more than a century been imported from the East in great quantities and during all that time has been

improving in its reputation, is, nevertheless, so very little understood, that it remains a doubt whether the animal that produces it be a hog, an ox, a goat, or a deer. When an animal with which we are so nearly connected, is so utterly unknown, how little must we know of many that are more remote and unserviceable! Yet naturalists proceed in the same train, enlarging their catalogues and their names, without endeavouring to find out the nature, and fix the precise history, of those with which we are very partially acquainted. It is the spirit of the scholars of the present age to be fonder of increasing the bulk of our knowledge, than its utility; of extending their conquests, than of improving their empire.

The musk which comes to Europe, is brought over in small bags, about the size of a pigeon's egg, which, when cut open, appear to contain a kind of dusky reddish substance, like coagulated blood, and which, in large quantities, has a very strong smell; but, when mixed and diffused, becomes a very agreeable perfume. Indeed, no substance now known in the world has a stronger or a more permanent smell. A grain of musk perfumes a whole room; and its odour continues for some days without diminution. But in a larger quantity it continues for years together, and seems scarcely wasted in its weight, although it has filled the atmosphere to a great distance with its parts. It is particularly used in medicine, in nervous and hysteric disorders; and is found in such cases to be the most powerful remedy now in use: however, the animal that furnishes this admirable medicine has been very variously described, and is known but very imperfectly.

The description given of this animal by Grew is as follows. "The musk animal is properly neither of the goat nor deer kind, for it has no horns, and it is uncertain whether it ruminates or not, however, it wants the fore-teeth in the upper jaw, in the same manner as in ruminating animals; but, at the same time, it has tusks like those of a hog. It is three feet six inches in length, from the head to the tail, and the head is above half a foot long. The fore-part of the head is like that of a greyhound, and the ears are three inches long, and erect, like those of a rabbit; but the tail is not above two inches. It is cloven-footed, like beasts of the goat kind; the hair on the head and legs

is half an inch long on the belly an inch and a half and on the back and buttocks three inches and proportionably thicker than in any other animal. It is brown and white alternately from the root to the point on the head and thighs it is brown but under the belly and tail white and a little curled especially on the back and belly. On each side of the lower jaw under the corners of the mouth there is a tuft of thick hair which is short and hard and about three quarters of an inch long. The hair in general of this animal is remarkable for its softness and fine texture but what distinguishes it particularly are the tusks which are an inch and a half long and turn back in the form of a hook and more particularly the bag which contains the musk which is three inches long two broad and stands out from the belly an inch and a half. It is a very fearful animal and therefore it has long ears and the sense of hearing is so quick that it can discover an enemy at a great distance.

After so long and circumstantial a description of this animal its nature is but very little known nor has any anatomist as yet examined its internal structure or been able to inform us whether it be a ruminant animal or one of the hog kind how the musk is formed or whether those bags in which it comes to us be really belonging to the animal or are only the sophistications of the venders. Indeed when we consider the immense quantities of this substance which are consumed in Europe alone not to mention the East where it is in still greater repute than here we can hardly suppose that any one animal can furnish the supply, and particularly when it must be killed before the bag can be obtained. We are told it is true that the musk is often deposited by the animal upon trees and stones against which it rubs itself when the quantity becomes uneasy but it is not in that form which we receive it but always in what seems to be its own natural bladder. Of these Taverner brought home near two thousand in one year and as the animal is wild so many must during that space have been hunted and taken. But as the creature is represented very shy and as it is found but in some particular provinces of the east the wonder is how its bag should be so cheap and furnished in such great plenty. The bag in common does not cost (if I do not forget) above a crown by retail and yet this is sup

posed the only one belonging to the animal, and for the obtaining of which, it must have been hunted and killed. The only way of solving this difficulty, is to suppose that these bags are, in a great measure, counterfeit, taken from some other animal, or from some part of the same, filled with its blood, and a very little of the perfume, but enough to impregnate the rest with a strong and permanent odour. It comes to us from different parts of the East, from China, Tonquin, Bengal, and often from Muscovy that of Thibet is reckoned the best, and sells for fourteen shillings an ounce; that of Muscovy the worst, and sells but for three; the odour of this, though very strong at first, being quickly found to evaporate. Musk was some years ago in the highest request as a perfume, and but little regarded as a medicine; but at present its reputation is totally changed. and having been found of great benefit in physic, it is but little regarded for the purposes of elegance. It is thus that things which become necessary, cease to continue pleasing, and the consciousness of their use, destroys their power of administering delight.

CHAP. V.

ANIMALS OF THE DEER KIND *

If we compare the stag and the bull, as to shape and form, no two animals can be more unlike, and yet, if we examine their internal structure, we shall find a striking similitude between them. Indeed, their differences, except to a nice observer, will scarcely be perceivable. All of the deer kind want the gall-bladder, their kidneys are formed differently, their spleen is also proportionably larger, their tail is shorter, and their horns, which are solid, are renewed

* The quadrupeds of this tribe have horns which are solid and branched they are renewed every year, and when young are clothed with a fine velvety vascular skin, which falls off when the horns have attained their full size. In the lower jaw they have eight front teeth, and are generally destitute of canine teeth but sometimes a single one is found on each side in the upper jaw. There are about fourteen distinct species. They are all extremely active, inhabiting chiefly woods and neglected situations, and in fighting not only make use of their horns, but stamp furiously with the fore-feet.

every year. Such are the slight internal discriminations between two animals one of which is among the swiftest, and the other the heaviest of the brute creation.

The stag is one of those innocent and perceptive animals that seem made to embellish the forest and animate the solitudes of nature. The easy elegance of his form the lightness of his motions those large branches that seem due rather for the ornament of his head than its defence the size the strength and the swiftness of this beautiful creature all sufficiently rank him among the first of quadrupeds among the most noted objects of human curiosity.

The stag or hart whose female is called a *hind* and the young a *calf* differs in size and in horns from a fallow deer. He is much larger and his horns are round whereas in the fallow kind they are broad and palmated. By these the animal's age is known. The first year the stag has no horns but a horny excrescence which is short, rough and covered with a thin hairy skin. The next year the horns are single and straight the third year they have two antlers three the fourth four the fifth and six the sixth this number is not always certain for sometimes there are more and often less. When arrived at the sixth year the antlers do not always increase and although the number may amount to six or seven on each side yet the animal's age is then estimated rather from the size of the antlers and the thickness of the branch which sustains them than from their variety. These horns large as they seem are notwithstanding shed every year and new ones come in their place. The old horns are of a firm solid texture and usually employed in making handles for knives and other domestic utensils. But, while young nothing can be more soft or tender and the animal as if conscious of his own imbecility at those times instantly upon shedding his former horns retires from the rest of his fellows and hides himself in solitudes and thickets never venturing out to pasture except by night. During this time which most usually happens in the spring the new horns are very painful and have a quick sensibility of any external impression. The flies also are extremely troublesome to him. When the old horn is fallen off the new does not begin immediately to appear but the bones of the skull are seen covered only with a transparent

periosteum or skin, which, as anatomists teach us, covers the bones of all animals. After a short time, however, this skin begins to swell, and to form a soft tumour, which contains a great deal of blood, and which begins to be covered with a downy substance that has the feel of velvet, and appears nearly of the same colour with the rest of the animal's hair. This tumour every day buds forward from the point like the graft of a tree, and, rising by degrees from the head, shoots out the antlers on either side, so that in a few days, in proportion as the animal is in condition, the whole head is completed. However, as was said above, in the beginning its consistence is very soft, and has a sort of bark, which is no more than a continuation of the integument of the skull. It is velvety and downy, and every where furnished with blood-vessels, that supply the growing horns with nourishment. As they creep along the sides of the branches, the point is marked over the whole surface; and the larger the blood-vessels, the deeper these marks are found to be: from hence arises the inequality of the surface of the deer's horns, which, as we see, are furrowed all along the sides, the impressions diminishing towards the point, where the substance is as smooth and as solid as ivory. But it ought to be observed, that this substance, of which the horns are composed, begins to harden at the bottom, while the upper part remains soft, and still continues growing. From whence it appears that the horns grow differently in deer from those of sheep or cows, in which they are always seen to increase from the bottom. However, when the whole head has received its full growth, the extremities then begin to acquire their solidity, the velvet covering, or bark, with its blood-vessels, dry up, and then begin to fall; and thus the animal hastens, by rubbing its antlers against every tree it meets. In this manner, the whole external surface being stripped off by degrees, at length the whole head acquires its complete hardness, expansion, and beauty.

It would be a vain task to inquire into the cause of the animal production of these horns; it is sufficient to observe, that if a stag be castrated when its horns are fallen off, they will never grow again; and, on the contrary, if the same operation is performed when they are on, they will never fall off. If only one of his testicles is taken

out he will want the horn or that side if one of the testicles only be tied up he will want the horn of the opposite side The increase of their provision also tends to facilitate the growth and the expansion of the horns and Mr Buffon thinks it possible to retard their growth entirely by greatly retrenching their food * As a proof of this nothing can be more obvious than the difference between a stag bred in fertile pastures and undisturbed by the hunter and one often pursued and ill nourished The former has his head expanded his antlers numerous and the branches thick the latter has but few antlers the trunks of the blood vessels upon them are but slight and the expansion but little The beauty and size of their horns therefore mark their strength and their vigour such of them as are sickly or have been wounded never shooting out that magnificent profusion so much admired in this animal Thus the horns may in every respect be resembled to a vegetable substance grafted upon the head of an animal Like a vegetable they grow from the extremities like a vegetable they are for a while covered with a bark that nourishes them like a vegetable they have their annual production and decay and a strong imagination might suppose that the leafy productions on which the animal feeds go once more to vegetate in his horns †

The stag is usually a twelvemonth old before the horns begin to appear and then a single branch is all that is seen for the year ensuing About the beginning of spring all of this kind are seen to shed their horns which fall off of themselves though sometimes the animal assists the efforts of nature by rubbing them against a tree It seldom happens that the branches on both sides fall off at the same time there often being two or three days between the dropping of the one and the other The old stags usually shed their horns first which generally happens towards the latter end of February or the beginning of March Those of the second herd (namely such as are between five and six years old,) shed their horns about the middle or latter end of March those still younger in the month of April and the youngest of all not till the middle or the latter end of May they generally shed

* Buffon vol x p 113

† M Buffon has supposed something like this Vide passim

them in pools of water, whither they retire from the heat ; and this has given rise to the opinion of their always hiding their horns. These rules, though true in general, are yet subject to many variations ; and universally it is known, that a severe winter retards the shedding of the horns. The horns of the stag generally increase in thickness and in height from the second year of its age to the eighth. In this state of perfection they continue during the vigour of life ; but as the animal grows old the horns feel the impressions of age, and shrink like the rest of the body. No branch bears more than twenty or twenty-two antlers, even in the highest state of vigour ; and the number is subject to great variety, for it happens that the stag at one year has either less or more than the year preceding, in proportion to the goodness of his pasture, or the continuance of his security, as these animals seldom thrive when often roused by the hunters. The horns are also found to partake of the nature of the soil. in the more fertile pastures they are large and tender ; on the contrary, in the barren soil, they are hard, stunted, and brittle. As soon as the stags have shed their horns, they separate from each other, and seek the plainer parts of the country, remote from every other animal, which they are utterly unable to oppose. They then walk with their heads stooping down, to keep their horns from striking against the branches of the trees above. In this state of imbecility they continue near three months, before their heads have acquired their full growth and solidity ; and then, by rubbing them against the branches of every thicket, they at length clear them of the skin which had contributed to their growth and nourishment. It is said by some, that the horn takes the colour of the sap of the tree against which it is rubbed, and that some thus become red, when rubbed against the heath, and others brown, by rubbing against the oak. this, however, is a mistake, since stags kept in parks where there are no trees, have a variety in the colour of their horns, which can be ascribed to nothing but nature. A short time after they have furnished their horns, they begin to feel the impressions of the rut, or the desire of copulation. The old ones are the most forward ; and about the end of August, or the beginning of September, they quit their

thickets and return to the mountain in order to seek the hind to whom they call with a loud tremulous note. At this time their neck is swollen they appear bold and furious, fly from country to country strike with their horns against the trees and other obstacles and continue restless and fierce until they have found the female who at first flies from them but is at last compelled and overtaken. When two stags contend for the same female how furious soever they may appear at other times they then seem agitated with an uncommon degree of ardour. They paw up the earth menace each other with their horns bellow with all their force and striking in a desperate manner against each other seem determined upon death or victory. This combat continues till one of them is defeated or flies and it often happens that the victor is obliged to fight several of those battles before it remains undisputed master of the field. The old ones are generally the conquerors upon these occasions, as they have more strength and greater courage and these also are preferred by the hind to the young ones as the latter are more feeble and less ardent. However they are all equally inconstant keeping to the female but a few days and then seeking out for another not to be enjoyed perhaps without a repetition of their former danger.

In this manner the stag continues to range from one to the other for about three weeks the time the rut continues during which he scarcely eats sleeps or rests but continues to pursue to combat and to enjoy. At the end of this period of madness for such in this animal it seems to be the creature that was before fat sleek and glossy becomes lean feeble and timid. He then retires from the herd to seek plenty and repose he frequents the side of the forest and chooses the most nourishing pastures remaining there till his strength is renewed. Thus is his whole life passed in the alternations of plenty and want of corpulence and inanition of health and sickness without having his constitution much affected by the violence of the change. As he is above five years coming to perfection he lives about forty years and it is a general rule that every animal lives about seven or eight times the number of years which it continues to grow. What therefore is reported concerning the life of this animal

has arisen from the credulity of ignorance: some say, that a stag having been taken in France, with a collar, on which were written these words, "Cæsar, hoc me donavit;" this was interpreted of Julius Cæsar, but it is not considered that Cæsar is a general name for kings, and that one of the emperors of Germany, who are always styled Cæsars, might have ordered the inscription

This animal may differ in the term of his life according to the goodness of his pasture, or the undisturbed repose he happens to enjoy. These are advantages that influence not only his age, but his size and his vigour. The stags of the plains, the valleys, and the little hills, which abound in corn and pasture, are much more corpulent and much taller than such as are bred on the rocky waste, or the heathy mountain. The latter are low, small, and meagre, incapable of going so swift as the former, although they are found to hold out much longer. They are also more artful in evading the hunters; their horns are generally black and short, while those of the lowland stags are reddish and flourishing, so that the animal seems to increase in beauty and stature in proportion to the goodness of the pasture, which he enjoys in security.

The usual colour of the stag in England was red, nevertheless, the greater number in other countries are brown. There are some few that are white, but these seem to have obtained this colour in a former state of domestic tameness. Of all the animals that are natives of this climate, there are none that have such a beautiful eye as the stag, it is sparkling, soft, and sensible. His senses of smelling and hearing are in no less perfection. When he is in the least alarmed, he lifts the head and erects the ears, standing for a few minutes as if in a listening posture. Whenever he ventures upon some unknown ground, or quits his native covering, he first stops at the skirt of the plain to examine all around; he next turns against the wind, to examine by the smell if there be any enemy approaching. If a person should happen to whistle or call out, at a distance, the stag is seen to stop short in his slow-measured pace, and gazes upon the stranger with a kind of awkward admiration, if the cunning animal perceives neither dogs nor fire-arms preparing against him, he goes forward, quite unconcerned, and slowly proceeds without

offering to fly. Man is not the enemy he is most afraid of on the contrary he seems to be delighted with the sound of the shepherd's pipe and the hunter sometimes makes use of that instrument to allure the poor animal to his destruction.

The stag eats slowly and is very delicate in the choice of his pasture. When he has eaten a sufficient he then retires to the covert of some thicket to chew the cud in security. His rumination however seems performed with much greater difficulty than with the cow or sheep for the grass is not returned from the first stomach without much straining and a kind of laceration which is easily perceived during the whole time it continues. This may proceed from the greater length of his neck and the narrowness of the passage all those of the cow and the sheep kind having it much wider.

This animal's voice is much stronger louder and more tremulous in proportion as he advances in age in the time of rut it is even terrible. At that season he seems so transported with passion that nothing obstructs his fury and when it bays he leaps the dogs off with great intrepidity. Some years ago William Duke of Cumberland caused a tiger and a stag to be enclosed in the same area and the stag made so bold a defence that the tiger was at last obliged to fly. The stag seldom drinks in the winter and still less in the spring while the plants are tender and covered over with dew. It is in the heat of summer and during the time of rut that he is seen constantly frequenting the sides of rivers and lakes as well to slake his thirst as to cool his ardour. He swims with great ease and strength and best at those times when he is fittest his fat keeping him buoyant like oil upon the surface of the water. During the time of rut he even ventures out to sea and swims from one island to another although there may be some leagues distance between them.

The cry of the hind or female is not so loud as that of the male and is never excited but by apprehension for herself or her young. It need scarcely be mentioned that she has no horns or that she is more feeble or unfit for hunting than the male. When once they have conceived they separate from the males and then they both herd apart. The time of gestation continues between eight and nine months.

and they generally produce but one at a time. Their usual season for bringing forth is about the month of May, or the beginning of June, during which they take great care to hide their young in the most obscure thickets. Nor is the precaution without reason, since almost every creature is then a formidable enemy. The eagle, the falcon, the osprey, the wolf, the dog, and all the rapacious family of the cat kind, are in continual employment to find out her retreat. But, what is more unnatural still, the stag himself is a professed enemy, and she is obliged to use all her arts to conceal her young from him, as from the most dangerous of her pursuers. At this season, therefore, the courage of the male seems transferred to the female, she defends her young against her less formidable opponents by force; and when pursued by the hunter, she ever offers herself, to mislead him from the principal object of her concern. She flies before the hounds for half the day, and then returns to her young, whose life she has thus preserved at the hazard of her own. The *calf*, for so the young of this animal is called, never quits the dam during the whole summer, and in winter, the hind, and all the males under a year old, keep together, and assemble in herds, which are more numerous in proportion as the season is more severe. In the spring they separate, the hinds to bring forth, while none but the year-olds remain together. These animals are, however, in general fond of herding and grazing in company, it is danger or necessity alone that separates them.

The dangers they have to fear from other animals, are nothing when compared to those from man. The men of every age and nation have made the chase of the stag one of their most favourite pursuits, and those who first hunted from necessity, have continued it for amusement. In our own country, in particular, hunting was ever esteemed as one of the principal diversions of the great. At first, indeed, the beasts of the chase had the whole island for their range, and knew no other limits than those of the ocean.

The Roman jurisprudence, which was formed on the manners of the first ages, established it as a law, that, as the natural right of things which have no master belongs to

the first possessor wild beasts birds and fishes are the property of whosoever could first take them. But the northern barbarians who overrun the Roman empire bringing with them the strongest relish for this amusement and being now possessed of more easy means of subsistence from the lands they had conquered their chiefs and leaders began to appropriate the right of hunting and instead of a natural right to make it a royal one. When the Saxon kings therefore had established themselves into a heptarchy the chases were reserved by each sovereign for his own particular amusement. Hunting and war in those uncivilized ages were the only employment of the great. Their active but uncultivated minds were susceptible of no pleasures but those of a violent kind such as gave exercise to their bodies and prevented the uneasiness of thinking. But as the Saxon kings only appropriated those lands to the business of the chase which were unoccupied before so no individuals received any injury. But it was otherwise when the Norman kings were settled upon the throne. The passion for hunting was then carried to an excess and every civil right was involved in general ruin. This ardour for hunting was stronger than the consideration of religion even in a superstitious age. The village communities nay even the most sacred edifices were thrown down and all turned into one vast waste to make room for animals the object of a lawless tyrant's pleasure. Singuinary laws were enacted to preserve the game and in the reigns of William Rufus and Henry I. it was less criminal to destroy one of the human species than a beast of chase. Thus it continued while the Norman line filled the throne but when the Saxon line was restored under Henry II. the rigour of the forest laws was softened. The barons also for a long time imitated the encroachments as well as the amusements of the monarch but when property became more equally divided by the introduction of arts and industry these extensive hunting grounds became more limited and as tillage and husbandry increased the beasts of chase were obliged to give way to others more useful to the community. Those vast tracts of land before dedicated to hunting were then contracted and in proportion as the useful arts gained ground they protected and encouraged the labours of the industrious and repressed the licentiousness of the sports.

man. It is, therefore, among the subjects of a despotic government only, that these laws remain in full force; where large wastes lie uncultivated for the purposes of hunting; where the husbandman can find no protection from the invasions of his lord, or the continual depredations of those animals which he makes the objects of his pleasure

In the present cultivated state of this country, therefore, the stag is unknown in its wild natural state, and such of them as remain among us are kept, under the name of *red deer*, in parks among the fallow-deer. But they are become less common than formerly, its excessive viciousness during the rutting-season, and the badness of its flesh, inducing most people to part with the species. The few that still remain wild are to be found on the moors that border on Cornwall and Devonshire; and in Ireland, on most of the large mountains of that country

In England, the hunting the stag and the buck are performed in the same manner, the animal is driven from some gentleman's park, and then hunted through the open country. But those who pursue the wild animal, have a much higher object, as well as a greater variety in the chase. To let loose a creature that was already in our possession, in order to catch it again, is, in my opinion, but a poor pursuit, as the reward, when obtained, is only what we before had given away. But to pursue an animal that owns no proprietor, and which he that first seizes may be said to possess, has something in it that seems at least more rational, this rewards the hunter for his toil, and seems to repay his industry. Besides, the superior strength and swiftness of the wild animal prolongs the amusement, it is possessed of more various arts to escape the hunter, and leads him to precipices where the danger ennobles the chase. In pursuing the animal let loose from a park, as it is unused to danger, it is but little versed in the stratagems of escape, the hunter follows as sure of overcoming, and feels none of those alternations of hope and fear which arise from the uncertainty of success. But it is otherwise with the mountain stag having spent his whole life in a state of continual apprehension,

having frequently been followed and as frequently expect he knows every trick to mislead to confound or intimidate his pursuers, to stimulate their ardour and enhance their success.

Those who hunt this animal have their peculiar terms for the different objects of their pursuit. The professors in every art take a pleasure in thus employing a language known only to themselves and thus accumulate words which to the ignorant have the appearance of knowledge. In this manner the stag is called the first year a *calf* or *hind calf* the second a *knobber* the third a *brock* the fourth a *staggard* the fifth a *stag* the sixth a *hart*. The female is called a *hind* the first year she is a *calf* the second a *hearse* the third a *hind*. This animal is said to *harbour* in the place where he resides. When he cries he is said to *bell* the print of his hoof is called the *slot* his tail is called the *single* his excrement the *fumet* his horns are called his *head* when simple the first year they are called *broches* the third year *spears* the fourth year that part which bears the antlers is called the *beam* and the little impression upon its surface *litters* those which rise from the crust of the beam are called *pearls*. The antler also have distinct names the first that branches off is called the *antler* the second the *sur antler* all the rest which grow afterwards till you come to the top which is called the *crown* are called *royal antlers* the little buds about the tops are called *croches*. The impression on the place where the stag has lain is called the *layer*. If it be in covert or a thicket it is called his *harbour*. When a deer has passed into a thicket leaving marks whereby his bulk may be guessed it is called an *entry*. When they cast their heads they are said to *men*. When they rub their heads against trees to bring off the peel of their horns they are said to *fray*. When a stag hard hunted takes to swimming in the water he is said to *go sail* when he turns his head against the hounds he is said to *bay* and when the hounds pursue upon the scent until they have unharboured the stag they are said to *draw on the slot*.

Such are but a few of the many terms used by hunters in pursuing of the stag most of which are now laid

aside, or in use only among game-keepers. The chase, however, is continued in many parts of the country where the red deer is preserved, and still makes the amusement of such as have not found out more liberal entertainments. In those few places where the animal is perfectly wild, the amusement, as was said above, is superior. The first great care of the hunter, when he leads out his hounds to the mountain side, where the deer are generally known to harbour, is to make choice of a proper stag to pursue. His ambition is to unharm the largest and the boldest of the whole herd; and for this purpose he examines the track, if there be any, which if he finds long and large, he concludes, that it must have belonged to a stag, and not a hind, the print of whose foot is rounder. Those marks also which he leaves on trees, by the rubbing of his horns, shew his size, and point him out as the proper object of pursuit. Now to seek out a stag in his haunt it is to be observed, that he changes his manner of feeding every month. From the conclusion of rutting time, which is in November, he feeds on heaths and broomy places. In December, they herd together, and withdraw into the strength of the forests, to shelter themselves from the severer weather, feeding on holm, elder-trees, and brambles. The three following months they leave herding, but keep four or five in a company, and venture out to the corners of the forest, where they feed on winter pasture, sometimes making then incursions into the neighbouring corn-fields, to feed upon the tender shoots, just as they peep above ground. In April and May they rest in thickets and shady places, and seldom venture forth unless roused by approaching danger. In September and October then annual ardour returns, and then they leave the thickets, boldly facing every danger, without any certain place for food or harbour. When, by a knowledge of these circumstances, the hunter has found out the residence, and the quality of his game, his next care is to uncouple and cast off his hounds in the pursuit. These no sooner perceive the timorous animal that flies before them, but they altogether open in full cry, pursuing rather by the scent than the view, encouraging each other to continue the chase, and tracing the flying animal with the most amazing

agility. The hunters also are not less ardent in their speed on horseback cheering up the dogs and directing them where to pursue. On the other hand the stag when unhounded flies at first with the swiftness of the wind leaving his pursuers several miles in the rear and at length having gained his former coverts and no longer hearing the cries of the dogs and men that he had just left behind he stops gazes round him and seems to recover his natural tranquillity. But this calm is of short duration for his inveterate pursuers slowly and securely trace him along and he once more hears the approaching destruction from behind. He again therefore renews his efforts to escape and again leaves his pursuers at almost the former distance, but this second effort makes him more feeble than before and when they come up a second time, he is unable to outstrip them with equal velocity. The poor animal now therefore is obliged to have recourse to all his little arts of escape which sometimes though but seldom avail him. In proportion as his strength fails him the ardour of his pursuers is inflamed he tracks more heavily on the ground and thus increasing the strength of the scent redoubles the cries of the hounds and enforces their speed. It is then that the stag seeks for refuge among the herd and tries every artifice to put off some other herd for his own. Sometimes he will send forth some little deer in his stead in the mean time lying close himself that the hounds may overshoot him. He will break into one thicket after another to find deer rousing them gathering them together and endeavouring to put them upon the tracks he has made. His old companions however with a true spirit of ingratitude now all forsake and shun him with the most watchful industry leaving the unhappy creature to take his fate by himself. Thus abandoned of his fellows he again tries other arts by doubling and crossing in some hard beaten highway where the scent is least perceivable. He now also runs against the wind not only to cool himself but the better to hear the voice and judge of the distance of his implacable pursuers. It is now easily perceivable how sorely he is pressed by his manner of running which from the bounding easy pace with which he began is converted into a stiff and short

manner of going; his mouth also is black and dry, without foam on it; his tongue hangs out; and the tears, as some say, are seen starting from his eyes. His last refuge, when every other method of safety has failed him, is to take the water, and to attempt an escape by crossing whatever lake or river he happens to approach. While swimming, he takes all possible care to keep in the middle of the stream, lest, by touching the bough of a tree, or the herbage on the banks, he may give scent to the hounds. He is also ever found to swim against the stream; whence the huntsmen have made it into a kind of proverb, *That he that would his chase find, must up with the river and down with the wind.* On this occasion too he will often cover himself under water, so as to shew nothing but the tip of his nose. Every resource, and every art, being at length exhausted, the poor creature tries the last remains of his strength, by boldly opposing those enemies he cannot escape, he therefore faces the dogs and men, threatens with his horns, guards himself on every side, and for some time stands at bay. In this manner, quite desperate, he furiously aims at the first dog or man that approaches, and it often happens that he does not die unrevenged. At that time, the more prudent, both of the dogs and men, seem willing to avoid him, but the whole pack quickly coming up, he is soon surrounded and brought down, and the huntsman winds a *triple mort*, as it is called, with his horn.

Such is the manner of pursuing this animal in England; but every country has a peculiar method of its own, adapted either to the nature of the climate, or the face of the soil. The ancient manner was very different from that practised at present; they used their dogs only to find out the game, but not to rouse it. Hence they were not curious as to the music of their hounds, or the composition of their pack, the dog that opened before he had discovered his game, was held in no estimation. It was their usual manner silently to find out the animal's retreat, and surround it with nets and engines, then to drive him up with all their cries, and thus force him into the toils which they had previously prepared. In succeeding times the fashion seemed to alter; and particularly in Sicily, the manner of hunting was as follows. The nobles and gentry being informed which way a herd of deer passed, gave notice to one another, and appointed

agility. The hunters also are not less ardent in their speed on horseback cheering up the dogs and directing them where to pursue. On the other hand the stag when unharrassed flies at first with the swiftness of the wind leaving his pursuers several miles in the rear and at length having gained his former covert and no longer hearing the cries of the dogs and men that he had just left behind he stops gazes round him and seems to recover his natural tranquillity. But this calm is of short duration for his inveterate pursuers slowly and securely trace him along and he once more hears the approaching destruction from behind. He again therefore renews his efforts to escape and again leaves his pursuers at almost the former distance but this second effort makes him more feeble than before and when they come up a second time he is unable to outstrip them with equal velocity. The poor animal now therefore is obliged to have recourse to all his little arts of escape which sometimes though but seldom avail him. In proportion as his strength fails him the ardour of his pursuers is inflamed he tricks more heavily on the ground and thus increasing the strength of the scent redoubles the cries of the hounds and enforces their speed. It is then that the stag seeks for refuge among the herd and tries every artifice to put off some other herd for his own. Sometimes he will send forth some little deer in his stead in the mean time lying close himself that the hounds may overshoot him. He will break into one thicket after another to find deer rousing them gathering them together and endeavouring to put them upon the tracks he has made. His old companions however with a true spirit of ingratitude now all forsake and shun him with the most watchful industry leaving the unhappy creature to take his fate by himself. Thus abandoned of his fellows he again tries other arts by doubling and crossing in some hard beaten highway where the scent is least perceivable. He now also runs against the wind not only to cool himself but the better to hear the voice and judge of the distance of his implacable pursuers. It is now easily perceivable how sorely he is pressed by his manner of running which from the bounding easy pace with which he began is converted into a stiff and short

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a day of hunting For this purpose every one was to bring a cross bow or a long bow and a bundle of staves shod with iron the heads bored with a cord passing through them all Thus provided they came to where the herd continued grazing and resting themselves about in a large ring surrounded the deer on every side Then each taking his stand unbound his figot set up his stake and tied the end of the cord to that of his next neighbour at the distance of about ten feet one from the other Between each of the strikes was hung a bunch of crimson feathers and so disposed that with the least breath of wind they would whirl round and preserve a sort of fluttering motion This done the persons who set up the staves withdrew and hid themselves

the chief hunts
man lines roused the
game and flying on all
sides red away by the

fluttering of the feathers and whirled about within this artificial paling still awed by the shining and fluttering plumage that encircled their retreat, the huntsman however still pursuing and calling every person by name as he passed by their stand commanded him to shoot the first third or sixth as he pleased and if any of them missed or singled out another than that assigned him it was considered as a most shameful mischance In this manner however the whole herd was at last destroyed and the day concluded with mirth and feasting *

The stags of China are of a particular kind for they are no taller than a common house dog and hunting them is one of the principal diversions of the great Their flesh while young is exceedingly good but when they arrive at maturity it begins to grow hard and tough however the tongue the muzzle and the ears are in particular esteem among that luxurious people Their manner of taking them is singular enough they carry with them the heads of some of the females stuffed and learn exactly to imitate their cry upon this the male does not fail to appear and looking on all sides perceives the head which is all that the hunter who is himself concealed discovers Upon their nearer approach the whole company rise surround and often take him alive

There are very few varieties in the red deer of this country; and they are mostly found of the same size and colour. But it is otherwise in different parts of the world, where they are seen to differ in form, in size, in horns, and in colour.

The stag of Corsica is a very small animal, being not above half the size of those common among us. His body is short and thick, his legs short, and his hair of a dark brown.

There is, in the forests of Germany, a kind of stag, named by the ancients the *Tragelaphus*, and which the natives call the *bran deer*, or the *brown deer*. This is of a darker colour than the common stag, of a lighter shade upon the belly, long hair upon the neck and throat, by which it appears bearded like the goat.

There is also a very beautiful stag, which, by some, is said to be a native of Sardinia; but others (among whom is Mr. Buffon) are of opinion that it comes from Africa, or the East Indies. He calls it the *axis*, after Pliny; and considers it as making the shade between the stag and the fallow-deer. The horns of the axis are round, like those of the stag, but the form of its body entirely resembles that of the buck, and the size also is exactly the same. The hair is of four colours; namely, sallow, white, black, and gray. The white is predominant under the belly, on the inside of the thighs, and the legs. Along the back there are two rows of spots in a right line, but those on other parts of the body are very irregular. A white line runs along each side of this animal, while the head and neck are gray. The tail is black above, and white beneath; and the hair upon it is six inches long.

Although there are but few individuals of the deer kind, yet the race seems diffused over all parts of the earth. The new continent of America, in which neither the sheep, the goat, nor the gazelle, have been originally bred, nevertheless produces stags, and other animals of the deer kind, in sufficient plenty. The Mexicans have a breed of white stags in their parks, which they call *stags royal* *. The stags of Canada differ from ours in nothing except the size of the horns, which in them is greater, and the direction of

* Buffon, vol. vii p. 35

the antlers which rather turn back than project forward as in those of Europe. The same difference of size that obtains among our stags is also to be seen in that country and as we are informed by Russel the Americans have brought them into the same state of domestic tameness that we have our sheep goats or black cattle. They send them forth in the day time to feed in the forests and at night they return home with the herdsman who guards them. The inhabitants have no other milk but what the hind produces and use no other cheese but what is made from thence. In this manner we find that an animal which seems made only for man's amusement may be easily brought to supply his necessities. Nature has many stores of happiness and plenty in reserve which only want the call of industry to be produced and now remain as candidates for human approbation *

THE FALLOW DEER

No two animals can be more nearly allied than the stag and the fallow deer †. Alike in form alike in disposition in the superb furniture of their herds in their swiftness and timidity and yet no two animals keep more distinct or avoid each other with more fixed animosity. They are never seen to herd in the same place they never engender together or form a mixed breed and even in those countries where the stag is common the buck seems to be entirely a stranger in short they both form distinct families, which though so seemingly near are still remote and although with the same habits yet retain an unalterable aversion. The fallow deer as they are much smaller so they seem of a nature less robust and less savage than those of the stag kind. They are found but rarely wild in the forests they are in general bred up in parks and kept for the purposes

* In the mountainous parts of Hircania Russia and Siberia is found a species of deer somewhat larger than the roe buck. The colour is brown with the outsides of the limbs and under parts of the body yellowish. The hinder parts of the thighs are white forming a large patch on the back of the animal. The space round the nose and sides of the lower lip are black but the tip of the lip is white. It has no tail but a mere broadish excrescence.

† Buffon vol. xii p. 36

of hunting, or of luxury, their flesh being preferred to that of any other animal. It need scarcely be mentioned, that the horns of the buck made its principal distinction, being broad and palmated; whereas those of the stag are in every part round. In the one, they are flatted and spread like the palm of the hand; in the other, they grow like a tree, every branch being of the shape of the stem that bears it. The fallow-deer also has the tail longer, and the hair lighter, than the stag; in other respects, they pretty near resemble one another.

The head of the buck, as of all other animals of this kind, is shed every year, and takes the usual time for repairing. The only difference between it and the stag is, that this change happens later in the buck; and its rutting-time consequently falls more into the winter. It is not found so furious at this season as the former; nor does it so much exhaust itself by the violence of its ardour. It does not quit its natural pastures in quest of the female, nor does it attack other animals with indiscriminate ferocity. However, the males combat for the female among each other, and it is not without many contests that one buck is seen to become master of the whole herd. It often happens also that a herd of fallow-deer is seen to divide into two parties, and engage each other with great ardour and obstinacy*. They both seem desirous of gaining some favourite spot of the park for pasture, and of driving the vanquished party into the coarser and more disagreeable parts. Each of these factions has its particular chief, namely, the two oldest and strongest of the herd. These lead on to the engagement, and the rest follow under their direction. These combats are singular enough, from the disposition and conduct which seems to regulate their mutual efforts. They attack with order, and support the assault with courage; they come to each other's assistance, they retire, they rally, and never give up the victory upon a single defeat. The combat is renewed for several days together, until at length the most feeble side is obliged to give way, and is content to escape to the most disagreeable part of the park, where only they can find safety and protection.

The fallow-deer is easily tamed, and feeds upon many

* Buffon, vol. xii p. 36.

things which the stag refuses. By this means it preserves its venison better, and even after rutting it does not appear entirely exhausted. It continues almost in the same state through the whole year although there are particular seasons when its flesh is chiefly in esteem. This animal also browses closer than the stag for which reason it is more prejudicial among young trees which it often strips too close for recovery. The young deer eat much faster and more greedily than the old they seek the female at their second year and like the stag are fond of variety. The doe goes with young about eight months like the hind and commonly brings forth one at a time but they differ in this that the buck comes to perfection at three and lives till sixteen whereas the stag does not come to perfection till seven and lives till forty.

As this animal is a beast of chase like the stag so the hunters have invented a number of names relative to him. The buck is the first year called a *faun* the second a *pricket* the third a *sorel* the fourth a *sore* the fifth a *buck of the first head* and the sixth a *great buck*. The female is called a *doe* the first year, a *faun* and the second a *tigg*. The manner of hunting the buck is pretty much the same as that of stag hunting except that less skill is required in the latter. The buck is more easily roused it is sufficient to judge by the view and mark what grove or covert it enters as it is not known to wander far from thence nor like the stag to change its *layer* or place of repose. When hard hunted it takes to some strong hold or covert with which it is acquainted in the more gloomy parts of the wood or the steep of the mountain not like the stag flying far before the hounds nor crossing nor doubling nor using any of the subtleties which the stag is accustomed to. It will take the water when sorely pressed but seldom a great river nor can it swim so long nor so swiftly as the former. In general the strength the cunning and the courage of this animal are inferior to those of the stag and consequently it affords neither so long so various nor so obstinate a chase besides being lighter and not tracking so deeply it leaves a less powerful and lasting scent and the dogs in the pursuit are more frequently at a fault.

As the buck is a more delicate animal than the stag so

also is it subject to greater varieties * We have in England two varieties of the fallow-deer, which are said to be of foreign origin · the beautiful spotted kind, which is supposed to have been brought from Bengal ; and the very deep brown sort that are now so common in several parts of this kingdom These were introduced by King James the First from Norway · for having observed their hardiness, and that they could endure the winter, even in that severe climate, without fodder, he brought over some of them into Scotland, and disposed of them among his chases Since that time they have multiplied in many parts of the British empire, and England is now become more famous for its venison than any other country in the world. Whatever pains the French have taken to rival us in this particular, the flesh of their fallow-deer, of which they keep but a few, has neither the fatness nor the flavour of that fed upon English pasture

However, there is scarcely a country in Europe, except far to the northward, in which this animal is a stranger. The Spanish fallow-deer are as large as stags, but of a darker colour, and a more slender neck · their tails are longer than those of ours, they are black above, and white below. The Virginian deer are larger and stronger than ours, with great necks, and their colour inclinable to gray Other kinds have the hoofs of their hind-legs marked outwardly with a white spot ; and their ears and tail much longer than the common. One of these has been seen full of white spots, with a black list down the middle of his back In Guiana, a country of South America, according to Labat, there are deer without horns, which are much less than those of Europe, but resembling them in every other particular. They are very lively, light of course, and excessively fearful, their hair is of a reddish sallow, their heads are small and lean, their ears little, their necks long and arched, the tail short, and the sight piercing. When pursued, they fly into places where no other animal can follow them The negroes, who pursue them, stand to watch for them in narrow paths, which lead to the brook, or the meadow where they feed ; there waiting in the utmost silence, for the slightest sound will drive them away, the negro, when he perceives the animal within reach, shoots, and is happy if he can bring

* British Zoology

down his game Their flesh though seldom fat is considered as a great delicacy and the hunter is well rewarded for his trouble *

THE ROE BUCK

THE Roe buck is the smallest of the deer kind known in our climate and is now almost extinct among us except in some parts of the Highlands of Scotland It is generally about three feet long and about two feet high The horns are from eight to nine inches long upright round and divided into only three branches The body is covered with very long hair well adapted to the rigour of its mountainous abode The lower part of each hair is ash colour near the ends is a narrow bar of black and the points are yellow The hairs on the face are black tipped with ash colour The ears are long their insides of a pale yellow and covered with long hair The spaces bordering on the eyes and mouth are black The chest belly and legs and the inside of the thighs are of a yellowish white the rump is of a pure white and the tail very short The make of this little animal is very elegant and its swiftness equals its beauty It differs from the fallow deer in having round horns and not flatted like theirs It differs from the stag in its smaller size and the proportionable prucity of its antlers and it differs from all of the goat kind as it annually sheds its head and obtains a new one which none of that kind are ever seen to do

* The accurate observer of nature Mr White in his Natural History of Selborne communicates an extraordinary provision with which these animals are endowed When they drink they plunge their noses deep under water and continue them in that situation a long time but to obviate any inconvenience which might arise from this kind of immersions they are furnished with two spiracles or vents one at the inner corner of each eye communicating with the nostrils and which they can open at pleasure These seem to be highly serviceable to them in the chase by affording them the means of respiration for without doubt these additional nostrils are thrown open when they are hard run M Lennant has likewise observed something analogous to this in the antelope This animal says he has a long slit beneath each eye which can be opened and shut at pleasure on holding an orange to one the creature made the same use of those orifices as of his nostrils applying them to the fruit and striving to smell it through them

As the stag frequents the thickest forests, and the sides of the highest mountains, the roe-buck, with humble ambition, counts the shady thicket, and the rising slope. Although less in size, and far inferior in strength to the stag, it is yet more beautiful, more active, and even more courageous. Its hair is always smooth, clean, and glossy; and it frequents only the driest places, and of the purest air. Though but a very little animal, as we have already observed, yet when its young is attacked, it faces even the stag himself, and often comes off victorious. All its motions are elegant and easy, it bounds without effort, and continues the course with but little fatigue. It is also possessed of more cunning in avoiding the hunter, is more difficult to pursue, and, although its scent is much stronger than that of the stag, it is more frequently found to make good a retreat. It is not with the roe-buck as with the stag, who never offers to use art until his strength is beginning to decline, this more cunning animal, when it finds that its first efforts to escape are without success, returns upon its former track, again goes forward, and again returns, until by its various windings it has entirely confounded the scent, and joined the last emanations to those of its former course. It then, by a bound, goes to one side, lies flat upon its belly, and permits the pack to pass by very near, without offering to stir.

But the roe-buck differs not only from the stag in superior cunning, but also in its natural appetites, its inclinations, and its whole habits of living. Instead of herding together, these animals live in separate families, the sire, the dam, and the young ones, associate together, and never admit a stranger into their little community. All others of the deer kind are inconstant in their affection, but the roe-buck never leaves its mate, and, as they have been generally bred up together from their first fawning, they conceive so strong an attachment, the male for the female, that they never after separate. Their rutting season continues but fifteen days, from the latter end of October to about the middle of November. They are not at that time, like the stag, overloaded with fat, they have not that strong odour, which is perceived in all others of the deer kind, they have none of those furious excesses; nothing,

* Buffon, vol. xii p 75

in short that alters their state they only drive away their fawns upon these occasions the buck forcing them to retire in order to make room for a succeeding progeny however when the copulating season is over the fawns return to their does and remain with them some time longer, after which they quit them entirely in order to begin an independent family of their own The female goes with young but five months and a half which alone serves to distinguish this animal from all others of the deer kind that continue pregnant more than eight In this respect she rather approaches more nearly to the goat kind from which however this race is separated by the male's annual casting its horns

When the female is ready to bring forth she seeks a retreat in the thickest part of the woods being no less apprehensive of the buck from whom she then separates than of the wolf the wild cat and almost every ravenous animal of the forest she generally produces two at a time and three but very rarely In about ten or twelve days these are able to follow the dam except in cases of warm pursuit when their strength is not equal to the fatigue Upon such occasions the tenderness of the dam is very extraordinary leaving them in the deepest thicket she offers herself to the danger flies before the hounds and does all in her power to lead them from the retreat where she has lodged her little ones Such animals as are nearly upon her own level she boldly encounters attacks the stag the wild cat and even the wolf and while she has life continues her efforts to protect her young Yet all her endeavours are often vain about the month of May which is her fawning time there is a greater destruction among those animals than at any other season of the year Numbers of the fawns are taken alive by the peasants numbers are found out and worried by the dogs and still more by the wolf which has always been their most inveterate enemy By these continual depredations upon this beautiful creature the roe buck is every day becoming scarcer and the whole race in many countries is wholly worn out They were once common in England the huntsmen who characterized only such beasts as they knew have given names to the different kinds and ages as to the stag thus they called it the first year a *hind* the

second, a *gyle*; and the third, a *hemusc*; but these names at present are utterly useless, since the animal no longer exists among us. Even in France, where it was once extremely common, it is now confined to a few provinces, and it is probable that in an age or two the whole breed will be utterly extirpated. Mr Buffon, indeed, observes, that in those districts where it is mostly found, it seems to maintain its usual plenty, and that the balance between its destruction and increase is held pretty even. However, the number in general is known to decrease, for wherever cultivation takes place, the beasts of nature are known to retire. Many animals that once flourished in the world may now be extinct, and the descriptions of Aristotle and Pliny, though taken from life, may be considered as fabulous, as their archetypes are no longer existing.

The fawns continue to follow the deer eight or nine months in all; and, upon separating, their horns begin to appear simple, and without antlers, the first year, as in those of the stag kind*. These they shed at the latter end of autumn, and renew during the winter, differing in this from the stag, who sheds them in spring, and renews them in summer. When the roe-buck's head is completely furnished, it rubs the horns against the trees in the manner of the stag, and thus strips them of the rough skin and the blood-vessels, which no longer contribute to their nourishment and growth. When these fall, and new ones begin to appear, the roe-buck does not retire, as the stag, to the covert of the wood, but continues its usual haunts, only keeping down its head to avoid striking its horns against the branches of trees, the pain of which it seems to feel with exquisite sensibility. The stag, who sheds his horns in summer, is obliged to seek a retreat from the flies, that at that time greatly incommode him, but the roe-buck, who sheds them in winter, is under no such necessity; and, consequently, does not separate from its little family, but keeps with the female all the year round†.

As the growth of the roe-buck, and its arrival at maturity, is much speedier than that of the stag, so its life is proportionably shorter. It seldom is found to extend above twelve or fifteen years, and, if kept tame, it does

* Buffon, vol. xii p 88

† Buffon, *ibid*.

not live above six or seven. It is an animal of a very delicate constitution requiring variety of food air and exercise. It must be paired with a female and kept in a park of at least a hundred acres. They may easily be subdued but never thoroughly tamed. No arts can teach them to be familiar with the feeder much less attached to him. They still preserve a part of their natural wildness and are subject to terrors without a cause. They sometimes in attempting to escape strike themselves with such force against the walls of their enclosure that they break their limbs and become utterly disabled. Whatever care is taken to tame them they are never entirely to be relied on as they have capricious fits of fierceness and sometimes strike at those they dislike with a degree of force that is very dangerous.

The cry of the roe buck is neither so loud nor so frequent as that of the stag. The young ones have a particular manner of calling to the dam which the hunters easily imitate and often thus allure the female to her destruction. Upon some occasions also they become in a manner intoxicated with their food which during the spring is said to ferment in their stomachs and they are then very easily taken. In summer they keep close under covert of the forest and seldom venture out except in violent heats to drink at some river or fountain. In general however they are contented to slake their thirst with the dew that falls on the grass and the leaves of trees and seldom risk their safety to satisfy their appetite. They delight chiefly in hilly grounds preferring the tender branches and buds of trees to corn or other vegetables and it is universally allowed that the flesh of those between one and two years old is the greatest delicacy that is known. Perhaps also the scarceness of it enhances its flavour.

In America this animal is much more common than in Europe. With us there are but two known varieties the red which is the larger sort and the brown with a spot behind which is less. But in the new continent the breed is extremely numerous and the varieties in equal proportion. In Louisiana where they are extremely common they are much larger than in Europe and the inhabitants live in a great measure upon its flesh which tastes like

mutton when well fatted They are found also in Brazil, where they have the name of *cuguacu apara*, only differing from ours in some slight deviations in the horns This animal is also said to be common in China; although such as have described it seem to confound it with the musk goat, which is of a quite different nature

THE ELK

WE have hitherto been describing minute animals in comparison of the elk; the size of which, from concurrent testimony, appears to be equal to that of the elephant itself. It is an animal rather of the buck than the stag kind, as its horns are flatted towards the top, but it is far beyond both in stature, some of them being known to be above ten feet high It is a native both of the old and new continent, being known in Europe under the name of the *elk*, and in America, by that of the *moose-deer* It is sometimes taken in the German and Russian forests, although seldom appearing, but it is extremely common in North America, where the natives pursue and track it in the snow The accounts of this animal are extremely various; some describing it as being no higher than a horse, and others above twelve feet high

As the stature of this creature makes its chief peculiarity, so it were to be wished that we could come to some precision upon that head If we were to judge of its size by the horns, which are sometimes fortuitously dug up in many parts of Ireland, we should not be much amiss in ascribing them to an animal at least ten feet high One of these I have seen, which was ten feet nine inches from one tip to the other From such dimensions, it is easy to perceive that it required an animal far beyond the size of a horse to support them To bear a head with such extensive and heavy antlers, required no small degree of strength, and without all doubt the bulk of the body must have been proportionable to the size of the horns. I remember some years ago to have seen a small moose-deer, which was brought from America by a gentleman of Ireland. it was about the size of a horse, and the horns were very little larger than those of a common stag this, therefore, serves to prove that the horns bear an exact proportion to the animal's size, the small elk has but

small horns whereas those enormous ones which we have described above must have belonged to a proportionable creature. In all the more noble animals Nature observes a perfect symmetry and it is not to be supposed she fails in this single instance. We have no reason therefore to doubt the accounts of Jocelyn and Dudley who affirm that they have been found fourteen spans which at nine inches to a span makes the animal almost eleven feet high. Others have extended their accounts to twelve and fourteen feet which makes this creature one of the most formidable of the forest.

There is but very little difference between the European elk and the American moose deer as they are but varieties of the same animal. It may be rather larger in America than with us as in the forests of that uncultivated country it receives less disturbance than in our own. In all places however it is timorous and gentle, content with its pasture and never willing to disturb any other animal when supplied itself. The European elk grows to above seven or eight feet high. In the year 1742 there was a female of this animal shown at Paris which was caught in a forest of Red Russia belonging to the Chirn of Tartary * it was then but young and its height was even at that time six feet seven inches but the describer observes that it has since become much taller and thicker so that we may suppose this female at least seven feet high. There have been no late opportunities of seeing the male but by the rule of proportion we may estimate his size at eight or nine feet at the least which is about twice as high as an ordinary horse. The height however of the female which was measured was but six feet seven inches Paris measure or almost seven English feet high. It was ten feet from the tip of the nose to the insertion of the tail and eight feet round the body. The hair was very long and coarse like that of a wild boar. The ears resembled those of a mule and were a foot and a half long. The upper jaw was longer by six inches than the lower and like other ruminating animals it had no teeth (cutting teeth I suppose the describer means). It had a large beard under the throat like a goat and in the middle of the forehead between the horns there was a bone as large as an egg. The nostrils

* Dictionnaire Raisonné des Animaux. Au Nom Elan

were four inches long on each side of the mouth. It made use of its fore-feet as a defence against its enemies. Those who shewed it, asserted that it ran with astonishing swiftness; and that it swam also with equal expedition, and was very fond of the water. They gave it thirty pounds of bread every day, besides hay, and it drank eight buckets of water. It was tame and familiar, and submissive enough to its keeper.

This description differs in many circumstances from that which we have of the moose, or American elk, which the French call the original. Of these there are two kinds, the common light gray moose, which is not very large, and the black moose, which grows to an enormous height. Mr. Dudley observes, that a doe or hind of the black moose kind, of the fourth year, wanted but an inch of seven feet high. All, however, of both kinds, have flat palmed horns, not unlike the fallow-deer, only that the palm is much larger, having a short trunk at the head, and then immediately spreading above a foot broad, with a kind of small antlers, like teeth, on one of the edges. In this particular, all of the elk kind agree; as well the European elk, as the gray and the black moose-deer.

The gray moose-deer is about the size of a horse, and, although it has large buttocks, its tail is not above an inch long. As in all of this kind the upper lip is much longer than the under, it is said that they continue to go backward as they feed. Their nostrils are so large that a man may thrust his hand in a considerable way, and their horns are as long as those of a stag, but, as was observed, much broader.

The black moose is the enormous animal mentioned above, from eight to twelve feet high. Jocelyn, who is the first English writer that mentions it, says, that it is a goodly creature, twelve feet high, with exceeding fan horns, that have broad palms, two fathoms from the top of one horn to another. He assures us that it is a creature, or rather a monster of superfluity, and many times bigger than an English ox. This account is confirmed by Dudley; but he does not give so great an expansion to the horns, measuring them only thirty-one inches between one tip and the other. However, that such an extraordinary animal as Jocelyn describes, has actually existed, we can make no manner of doubt of, since there are horns com-

mon enough to be seen among us twelve feet from one tip to the other

The animals delight in cold countries, feeding upon grass in summer and the bark of trees in winter. When the whole country is deeply covered with snow the moose deer herd together under the tall pine trees strip off the bark and remain in that part of the forest while it yields them subsistence. It is at that time that the natives prepare to hunt them and particularly when the sun begins to melt the snow by day which is frozen again at night for then the icy crust which covers the surface of the snow is too weak to support so great a bulk and only retards the animal's motion. When the Indians therefore perceive a herd of these at a distance they immediately prepare for their pursuit which is not as with us the sport of an hour but is attended with toil difficulty and danger*. The timorous animal no sooner observes its enemies approach than it immediately endeavours to escape but sinks at every step it takes. Still however it pursues its way through a thousand obstacles the snow which is usually four feet deep yields to its weight and embarrasses its speed the sharp ice wounds its feet and its lofty horns are entangled in the branches of the forest as it passes along. The trees however are broken down with ease and wherever the moose deer runs it is perceived by the snapping off the branches of the trees as thick as a man's thigh with its horns. The chase lasts in this manner for the whole day and sometimes it has been known to continue for two or three days together for the pursuers are often not less excited by famine than the pursued by fear. Their perseverance however generally succeeds and the Indian who first comes near enough darts his lance with unerring aim which sticks in the poor animal and at first increases its efforts to escape. In this manner the moose trots heavily on (for that is its usual pace) till its pursuers once more come up and repeat their blow upon this it again summons up sufficient vigour to get a head but at last quite tired and spent with loss of blood it sinks as the describer expresses it like a ruined building and makes the earth shake beneath its fall.

This animal when killed is a very valuable acquisition to the hunters. The flesh is very well tasted and said to

be very nourishing. The hide is strong, and so thick that it has been often known to turn a musket-ball; however, it is soft and pliable, and, when tanned, the leather is extremely light, yet very lasting. The fur is a light gray in some, and blackish in others, and when viewed through a microscope, appears spongy like a bulrush, and is smaller at the roots and points than in the middle; for this reason, it lies very flat and smooth, and though beaten or abused never so much, it always returns to its former state. The horns also are not less useful, being applied to all the purposes for which hartshorn is beneficial: these are different in different animals; in some they resemble entirely those of the European elk, which spread into a broad palm, with small antlers on one of the edges, in others they have a branched brow-antler between the bur and the palm, which the German elk has not; and in this they entirely agree with those whose horns are so frequently dug up in Ireland. This animal is said to be troubled with the epilepsy, as it is often found to fall down when pursued, and thus becomes an easier prey, for this reason, an imaginary virtue has been ascribed to the hinder hoof; which some have supposed to be a specific against all epileptic disorders. This, however, may be considered as a vulgar error, as well as that of its curing itself of this disorder by applying the hinder hoof behind the ear. After all, this animal is but very indifferently and confusedly described by travellers, each mixing his account with something false or trivial; often mistaking some other quadruped for the elk, and confounding its history. Thus some have mistaken it for the rein-deer, which, in every thing but size, it greatly resembles, some have supposed it to be the same with the Tapuette,* from which it entirely differs; some have described it as the common red American stag, which scarcely differs from our own, and, lastly, some have confounded it with the Bubalus, which is more properly a gazelle of Africa †

THE REIN-DEER †

OF all animals of the deer kind, the rein-deer is the most extraordinary and the most useful. It is a native of

* Condamine † Dapper, Description de l'Afrique, p. 17

‡ In the elk the horns are stemless, or branched from the base, in the rein-deer the horns are round, bent back, and palmated at the extremities

the icy regions of the north and though many attempts have been made to accustom it to a more southern climate it shortly feels the influence of the change and in a few months declines and dies. Nature seems to have fitted it entirely to answer the necessities of that hardy race of mankind that live near the pole. As these would find it impossible to subsist among their barren snowy mountains without its aid so this animal can live only there where its assistance is most absolutely necessary. From it alone the natives of Lapland and Greenland supply most of their wants it answers the purposes of a horse to convey them and their scanty furniture from one mountain to another it answers the purposes of a cow in giving milk and it answers the purposes of the sheep in furnishing them with a warm though a homely kind of clothing. From this quadruped alone therefore they receive as many advantages as we derive from three of our most useful creatures so that Providence does not leave these poor outcasts entirely destitute but gives them a faithful domestic more patient and serviceable than any other in nature.

The rein deer resembles the American elk in the fashion of its horns. It is not easy in words to describe these minute differences nor will the reader perhaps have a distinct idea of the similitude when told that both have brow antlers very large and hanging over their eyes palmed towards the top and bending forward like a bow. But here the similitude between these two animals ends for as the elk is much larger than the stag so the rein deer is much smaller. It is lower and stronger built than the stag its legs are shorter and thicker and its hoofs much broader than in that animal its hair is much thicker and warmer its horns much larger in proportion and branching forward over its eyes its ears are much larger its pace is rather a trot than a bounding and thus it can continue for a whole day its hoofs are cloven and moveable so that it spreads them abroad as it goes to prevent its sinking in the snow. When it proceeds on a journey it lays its great horns on its back while there are two branches which always hang over its forehead and almost cover its face. One thing seems peculiar to this animal and the elk which is, that as they move along

their hoofs are heard to crack with a pretty loud noise This arises from their manner of treading, for as they rest upon their cloven hoof, it spreads on the ground, and the two divisions separate from each other, but when they lift it, the divisions close again, and strike against each other with a crack The female also of the rein-deer has hoins as well as the male, by which the species is distinguished from all other animals of the deer kind whatsoever.

When the rein-deer first shed their coat of hair, they are brown, but in proportion as summer approaches, their hair begins to grow whitish, until, at last, they are nearly gray* They are, however, always black about the eyes The neck has long hair, hanging down, and coarser than upon any other part of the body The feet, just at the insertion of the hoof, are surrounded with a ring of white. The hair in general stands so thick over the whole body, that if one should attempt to separate it, the skin will nowhere appear uncovered whenever it falls also, it is not seen to drop from the root, as in other quadrupeds, but seems broken short near the bottom, so that the lower part of the hair is seen growing, while the upper falls away The hoins of the female are made like those of the male, except that they are smaller and less branching. As in the rest of the deer kind, they sprout from the points, and also in the beginning are furnished with a hairy crust, which supports the blood-vessels of most exquisite sensibility The rein-deer shed their horns, after rutting time, at the latter end of November, and they are not completely furnished again till towards autumn The female always retains her's till she brings forth, and then sheds them about the beginning of November If she be barren, however, which is not unfrequently the case, she does not shed them till winter The castration of the rein-deer does not prevent the shedding of their horns: those which are the strongest cast them early in winter; those which are more weakly, not so soon Thus, from all these circumstances, we see how greatly this animal differs from the common stag The female of the rein-deer has horns, which the hind is never seen to have; the rein-deer,

* For the greatest part of this description of the rein-deer, I am obliged to Mr Hoffberg, upon whose authority, being a native of Sweden, and experienced naturalist, we may confidently rely

when castrated renews its horns, which we are assured the stag never does. It differs not less in its habits and manner of living being tame, submissive and patient, while the stag is wild, capricious and unmanageable.

The rein deer as was said is naturally an inhabitant of the countries bordering on the arctic circle. It is not unknown to the natives of Siberia. The North Americans also hunt it under the name of the *caribou*. But in Lapland this animal is converted to the utmost advantage and some herdsmen of that country are known to possess above a thousand in a single herd.

Lapland is divided into two districts the mountainous and the woody. The mountainous part of the country is at best barren and bleak excessively cold and uninhabitable during the winter still however it is the most desirable part of this frightful region and is most thickly peopled during the summer. The natives generally reside on the declivity of the mountains three or four cottages together and lead a cheerful and social life. Upon the approach of winter they are obliged to migrate into the plains below each bringing down his whole herd which often amounts to more than a thousand and leading them where the pasture is in greatest plenty. The woody part of the country is much more desolate and hideous. The whole face of nature there presents a frightful scene of trees without fruit and plains without verdure. As far as the eye can reach nothing is to be seen even in the midst of summer but barren fields covered only with a moss almost as white as snow no grass no flowery landscapes only here and there a pine tree which may have escaped the frequent conflagrations by which the natives burn down their forests. But what is very extraordinary is the whole surface of the country is clothed in white so on the contrary the forests seem to the last degree dark and gloomy. While one kind of moss makes the fields look as if they were covered with snow another kind blackens over all the trees and even hides their verdure. This moss however which deforms the country serves for its only support as upon it alone the rein deer can subsist. The inhabitants who during the summer lived among the mountains drive down their herds in winter and people the plains and woods below. Such of the Laplanders

as inhabit the woods and the plains all the year round, live remote from each other, and having been used to solitude, are melancholy, ignorant, and helpless. They are much poorer also than the mountaineers, for, while one of those is found to possess a thousand rein-deer at a time, none of these are ever known to rear the tenth part of that number. The rein-deer makes the riches of this people, and the cold mountainous parts of the country agree best with its constitution. It is for this reason, therefore, that the mountains of Lapland are preferred to the woods; and that many claim an exclusive right to the tops of hills, covered in almost eternal snow. As soon as the summer begins to appear, the Laplander, who had fed his rein-deer upon the lower grounds during the winter, then drives them up to the mountains, and leaves the woody country, and the low pasture, which at that season are truly deplorable. The gnats bred by the sun's heat in the marshy bottoms and the weedy lakes, with which the country abounds more than any other part of the world, are all upon the wing, and fill the whole air like clouds of dust in a dry windy day. The inhabitants, at that time, are obliged to daub their faces with pitch, mixed with milk, to shield their skins from their depredations. All places are then so greatly infested, that the poor natives can scarcely open their mouths without fear of suffocation, the insects enter, from their numbers and minuteness, into the nostrils and the eyes, and do not leave the sufferer a moment at his ease. But they are chiefly enemies to the rein-deer; the horns of that animal being then in their tender state, and possessed of extreme sensibility, a famished cloud of insects instantly settle upon them, and drive the poor animal almost to distraction. In this extremity, there are but two remedies to which the quadruped, as well as its master, are obliged to have recourse. The one is, for both to take shelter near the cottage, where a large fire of tree-moss is prepared, which filling the whole place with smoke, keeps off the gnats, and thus by one inconvenience expels a greater, the other is, to ascend to the highest summit of the mountains, where the air is too thin, and the weather too cold, for the gnats to come. There the rein-deer are seen to continue the whole day, although without food, rather than to venture

down into the lower parts where they can have no defence against their unceasing persecutors. Besides the gnat there is also a gadfly that during the summer season is no less formidable to them. This insect is bred under their skins where the egg has been deposited the preceding summer and it is no sooner produced as a fly than it again endeavours to deposit its eggs in some place similar to that from whence it came. Whenever therefore it appears flying over a herd of rein deer it puts the whole body how numerous soever into motion they know their enemy and do all they can by tossing their horns and running among each other to terrify or avoid it. All their endeavours however are too generally without effect the gadfly is seen to deposit its eggs which burrowing under the skin wound it in several places and often bring on an incurable disorder. In the morning therefore as soon as the Lapland herdsman drives his deer to pasture his greatest care is to keep them from scaling the summits of the mountains where there is no food but where they go merely to be at ease from the gnats and gadflies that are ever annoying them. At this time there is a strong contest between the dogs and the deer the one endeavouring to climb up against the side of the hill and to gain those summits that are covered in eternal snows the other forcing them down by barking and threatening and in a manner compelling them into the places where their food is in the greatest plenty. There the men and dogs confine them guarding them with the utmost precaution the whole day and driving them home at the proper seasons for milking.

The female brings forth in the middle of May and gives milk till about the middle of October. Every morning and evening during the summer the herdsman returns to the cottage with his deer to be milked where the women previously have kindled up a smoky fire which effectually drives off the gnats and keeps the rein deer quiet while milking. The female furnishes about a pint which though thinner than that of the cow is nevertheless sweeter and more nourishing. This done the herdsman drives them back to pasture as he neither folds nor houses them neither provides for their subsistence during the winter nor improves their pasture by cultivation.

Upon the return of the winter, when the gnats and flies are no longer to be feared, the Laplander descends into the lower grounds; and as there are but few to dispute the possession of that desolate country, he has an extensive range to feed them in. Their chief, and almost their only food at that time, is the white moss already mentioned; which, from its being fed upon by this animal, obtains the name of the *lichen rangiferinus*. This is of two kinds, the woody lichen, which covers almost all the desert parts of the country like snow, the other is black, and covers the branches of the trees in very great quantities. However unpleasing these may be to the spectator, the native esteems them as one of his choicest benefits, and the most indulgent gift of nature. While his fields are clothed with moss, he envies neither the fertility nor the verdure of the more southern landscape, dressed up warmly in his deer-skin clothes, with shoes and gloves of the same materials, he drives his herd along the desert, fearless and at ease, ignorant of any higher luxury than what their milk and smoke-dried flesh afford him. Hardened to the climate, he sleeps in the midst of ice, on awaking, dozes away his time with tobacco, while his faithful dogs supply his place, and keep the herd from wandering. The deer, in the mean time, with instincts adapted to the soil, pursue their food, though covered in the deepest snow. They turn it up with their noses, like swine, and even though its surface be frozen and stiff, yet the hide is so hardened in that part, that they easily overcome the difficulty. It sometimes, however, happens, though but rarely, that the winter commences with rain, and a frost ensuing, covers the whole country with a glazed crust of ice. Then, indeed, both the rein-deer and the Laplander are undone; they have no provisions laid up in case of accident, and the only resource is to cut down the large pine-trees that are covered with moss, which furnishes but a scanty supply; so that the greatest part of the herd is then seen to perish without a possibility of assistance. It sometimes also happens, that even this supply is wanting; for the Laplander often burns down his woods, in order to improve and fertilize the soil which produces the moss upon which he feeds his cattle.

In this manner, the pastoral life is still continued near

the pole, neither the coldness of the winter nor the length of the nights neither the wildness of the forest nor the vagrant disposition of the herd interrupt the even tenor of the Laplander's life. By night and day he is seen attending his favourite cattle and remains unaffected in a season which would be speedy death to those bred up in a milder climate. He gives himself no uneasiness to house his herds or to provide a winter subsistence for them, he is at the trouble neither of manuring his grounds nor bringing in his harvests he is not the hurling of another's luxury all his labours are to obviate the necessities of his own situation and these he undergoes with cheerfulness as he is sure to enjoy the fruits of his own industry. If therefore we compare the Laplander with the peasant of more southern climates we shall have little reason to pity his situation the climate in which he lives is rather terrible to us than to him and as for the rest he is blessed with liberty plenty and ease. The rein deer alone supplies him with all the wants of life and some of the conveniences serving to shew how many advantages nature is capable of supplying when necessity gives the call. Thus the poor little helpless native who was originally perhaps driven by fear or famine into those inhospitable climates would seem at first view to be the most wretched of mankind but it is far otherwise he looks round among the few wild animals that his barren country can maintain and singles out one from among them and that of a kind which the rest of mankind have not thought worth taking from a state of nature this he cultivates propagates and multiplies and from this alone derives every comfort that can soften the severity of his situation.

The rein deer of this country are of two kinds the wild and the tame. The wild are larger and stronger but more mischievous than the others. Their breed however is preferred to that of the tame and the female of the latter is often sent into the woods from whence she returns home impregnated by one of the wild kind. These are fitter for drawing the sledge to which the Laplander accustoms then betimes and yokes them to it by a strap which goes round the neck and comes down between their legs. The sledge is extremely light and shod at the bottom with the skin of a young deer the hair turned to slide on the

frozen snow. The person who sits on this guides the animal with a cord, fastened round the horns, and encourages it to proceed with his voice, and drives it with a goad. Some of the wild breed, though by far the strongest, are yet found refractory, and often turn upon their drivers; who have then no other resource but to cover themselves with their sledge, and let the animal vent its fury upon that. But it is otherwise with those that are tame; no creature can be more active, patient, and willing, when hard pushed, they will trot nine or ten Swedish miles, or between fifty and sixty English miles, at one stretch. But, in such a case, the poor obedient creature fatigues itself to death, and, if not prevented by the Laplander, who kills it immediately, it will die in a day or two after. In general, they can go about thirty miles without halting, and this without any great or dangerous efforts. Thus, which is the only manner of travelling in that country, can be performed only in winter, when the snow is glazed over with ice, and although it be a very speedy method of conveyance, yet it is inconvenient, dangerous, and troublesome.

In order to make these animals more obedient, and more generally serviceable, they castrate them; which operation the Laplanders perform with their teeth, these become sooner fat when taken from labour; and they are found to be stronger in drawing the sledge. There is usually one male left entire for every six females, these are in rut from the feast of St. Matthew to about Michaelmas. At this time their horns are thoroughly burnished, and their battles among each other are fierce and obstinate. The females do not begin to breed till they are two years old; and then they continue regularly breeding every year till they are superannuated. They go with young above eight months, and generally bring forth two at a time. The fondness of the dam for her young is very remarkable; it often happens that when they are separated from her, she will return from pasture, keep calling round the cottage for them, and will not desist until, dead or live, they are brought and laid at her feet. They are at first of a light brown; but they become darker with age, and at last the old ones are of a brown, almost approaching to blackness. The young follow the dam for two or three years, but they do not acquire their full growth until four. They are then broke in, and

managed for drawing the sledge and they continue serviceable for four or five years longer. They never live above fifteen or sixteen years and when they arrive at the proper age the Laplander generally kills them for the sake of their skins and their flesh. This he performs by striking them on the back of the neck with his knife into the spinal marrow upon which they instantly fall and he then cuts the arteries that lead to the heart and lets the blood discharge itself into the cavity of the breast.

There is scarcely any part of this animal that is not converted to its peculiar uses. As soon as it begins to grow old and some time before the rut it is killed and the flesh dried in the air. It is also sometimes hardened with smoke and laid up for travelling provision when the natives migrate from one part of the country to another. During the winter the rein deer are slaughtered as sheep with us, and every four persons in the family are allowed one rein deer for their week's subsistence. In spring they spare the herd as much as they can and live upon fresh fish. In summer the milk and curd of the rein deer makes their chief provision and in autumn they live wholly upon fowls which they kill with a cross bow or catch in springs. Nor is this so scanty an allowance since at that time the sea fowls come in such abundance that their ponds and springs are covered over. These are not so shy as with us but yield themselves an easy prey. They are chiefly allured to those places by the swarms of gnats which infest the country during summer and now repay the former inconveniences by inviting such numbers of birds as supply the natives with food a fourth part of the year in great abundance.

The milk when newly taken is warmed in a cauldron and thickened with rennet and then the curd is pressed into cheeses which are little and well tasted. These are never found to breed mites as the cheese of other countries probably because the mite fly is not to be found in Lapland. The whey which remains is warmed up again and becomes of a consistence as if thickened with the white of eggs. Upon this the Laplanders feed during the summer it is pleasant and well tasted but not very nourishing. As to butter they very seldom make any because the milk affords but a very small quantity and this both in taste and consistence is more nearly resembling to suet. They never

keep their milk till it turns sour; and do not dress it into the variety of dishes which the more southern countries are known to do. The only delicacy they make from it is with wood-sorrel, which being boiled up with it, and coagulating, the whole is put into casks, or deer skins, and kept under ground to be eaten in winter.

The skin is even a more valuable part of this animal than either of the former. From that part of it which covered the head and feet, they make their strong snow-shoes, with the hair on the outside. Of the other parts they compose their garments, which are extremely warm, and which cover them all over. The hair of these also is on the outside; and they sometimes line them with the fur of the glutton, or some other warm-furred animal of that climate. These skins also serve them for beds. They spread them on each side of the fire, upon some leaves of the dwarf birch-tree, and in this manner lie both soft and warm. Many garments made of the skin of the rein-deer are sold every year to the inhabitants of the more southern parts of Europe, and they are found so serviceable in keeping out the cold, that even people of the first rank are known to wear them.

In short, no part of this animal is thrown away as useless. The blood is preserved in small casks, to make sauce with the marrow in spring. The horns are sold to be converted into glue. The sinews are dried, and divided so as to make the strongest kind of sewing thread, not unlike catgut. The tongues, which are considered as a great delicacy, are dried, and sold into the more southern provinces. The intestines themselves are washed like our tups, and in high esteem among the natives. Thus the Laplander finds all his necessities amply supplied from this single animal, and he who has a large herd of these animals has no idea of higher luxury.

But although the rein-deer be a very hardy and vigorous animal, it is not without its diseases. I have already mentioned the pain it feels from the gnat, and the apprehensions it is under from the gadfly. Its hide is often found pierced in a hundred places, like a sieve, from this insect, and not a few die in their third year from this very cause. Their teats also are subject to cracking, so that blood comes instead of milk. They sometimes take a loathing for their food, and, instead of eating, stand still and chew the cud. They are

also troubled with a vertigo like the elk, and turn round often till they die. The Laplander judges of their state by the manner of their turning. If they turn to the right he judges their disorder but slight. If they turn to the left, he deems it incurable. The rein deer are also subject to ulcers near the hoof which unqualifies them for travelling, or keeping with the herd. But the most fatal disorder of all is that which the natives call the *suddatala* which attacks this animal at all seasons of the year. The instant it is seized with this disease it begins to breathe with greater difficulty its eyes begin to stare and its nostrils to expand. It acquires also an unusual degree of ferocity and attacks all it meets indiscriminately. Still however it continues to feed as if in health but is not seen to chew the cud and it lies down more frequently than before. In this manner it continues every day consuming and growing more lean till at last it dies from mere inanition and not one of those that are attacked with this disorder are ever found to recover. Notwithstanding it is but very lately known in that part of the world although during the last ten or fifteen years it has spoiled whole provinces of this necessary creature. It is contagious and the moment the Laplander perceives any of his herd infected he hastens to kill them immediately before it spreads any further. When examined internally there is a frothy substance found in the brain and round the lungs the intestines are lax and flabby and the spleen is diminished almost to nothing. The Laplanders only cure in all these disorders is to anoint the animal's back with tar. If this does not succeed he considers the disease as beyond the power of art and with his natural phlegm submits to the severities of fortune.

Besides the natural maladies of this animal there are some external enemies which it has to fear. The bears now and then make depredations upon the herd but of all their persecutors the creature called the *glutton* is the most dangerous and the most successful. The war between these is carried on not less in Lapland than in North America where the rein deer is called the *caribou* and the *glutton* the *carajou*. This animal which is not above the size of a badger waits whole weeks together for its prey hid in the branches of some spreading tree and when the wild rein deer passes underneath it instantly drops down upon it,

fixing its teeth and claws into the neck, just behind the horns. It is in vain that the wounded animal then flies for protection, that it rustles among the branches of the forest, the glutton still holds its former position, and, although it often loses a part of its skin and flesh, which are rubbed off against the trees, yet it still keeps fast until its prey drops with fatigue and loss of blood. The deer has but one only method of escape, which is by jumping into the water. that element its enemy cannot endure, for, as we are told, it quits its hold immediately, and then thinks only of providing for its own proper security.

[Mr Pennant has described a remarkably small kind of deer, which was brought from Bengal, and was in the possession of the late Lord Clive. Its general colour was brown, the belly and rump lighter, the horns were slender, about thirteen inches long, with a single branch at the base of each, and forked at the tips. The body, from the tip of the nose to the tail, was three feet six inches long, the tail measured eight inches, the height, from the shoulder to the hoof, was two feet two inches, behind it was about two inches higher, the legs were so fine and slender, that, like those of the pigmy antelope and musk, they were often capped with gold, and made use of as tobacco-stoppers.]

BOOK III

QUADRUPIDS OF THE HOG KIND*

CHAP. I

INTRODUCTION

ANIMALS of the hog kind seem to unite in themselves all those distinctions by which others are separated. They resemble those of the horse kind in the number of their teeth, which in all amount to forty four in the length of their head and in having but a single stomach. They resemble the cow kind in their cloven hoofs and the position of their intestines and they resemble those of the claw footed kind in their appetite for flesh in their not chewing the cud and in their numerous progeny. Thus this species serves to fill up that chasm which is found between the carnivorous kinds and those that live upon grass being possessed of the ravenous appetite of the one and the inoffensive nature of the other. We may consider them therefore as of a middle nature which we can refer neither to the rapacious nor the peaceable kinds and yet partaking somewhat of the nature of both. Like the rapacious kinds they are found to have short intestines their hoofs also though cloven to the sight will upon anatomical inspection appear to be supplied with bones like beaks of prey and the number of their teats also increase the similitude on the other hand in a natural state they live upon vegetables and seldom seek after animal food except when urged by necessity. They offend no other animal of the forest at the same time that they are furnished with arms to terrify the bravest.

* The animals of this tribe have four front teeth in the upper jaw which converge at the two points and generally six in the lower jaw which project. The canine teeth or tusks are two in each jaw those in the upper jaw short those in the lower jaw extending beyond the mouth. The snout is prominent moveable and has the appearance of having been abruptly cut off the hoofs are cloven.

THE WILD BOAR,

WHICH is the original of all the varieties we find in this creature, is by no means so stupid, nor so filthy an animal, as that we have reduced to tameness; he is much smaller than the tame hog, and does not vary in his colour as those of the domestic kind do, but is always found of an iron gray, inclining to black, his snout is much longer than that of the tame hog, and the ears are shorter, rounder, and black; of which colour are also the feet and the tail. He roots the ground in a different manner from the common hog, for as this turns up the earth in little spots here and there, so the wild boar ploughs it up like a furrow, and does irreparable damage in the cultivated lands of the farmer. The tusks also of this animal are larger than in the tame breed, some of them being seen almost a foot long*. These, as is well known, grow from both the under and upper jaw, bent upwards circularly, and are exceedingly sharp at the points. They differ from the tusks of the elephant in this, that they never fall; and it is remarkable of all the hog kind, that they never shed their teeth as other animal are seen to do. The tusks of the lower jaw are always the most to be dreaded, and are found to give very terrible wounds.

The wild boar can properly be called neither a solitary nor a gregarious animal. The three first years the whole litter follows the sow, and the family lives in a herd together. They are then called beasts of company, and unite their common forces against the invasions of the wolf, or the more formidable beasts of prey. Upon this their principal safety, while young, depends, for, when attacked, they give each other mutual assistance, calling to each other with a very loud and fierce note; the strongest face the danger; they form a ring, and the weakest fall into the centre. In this position few ravenous beasts dare venture to attack them, but pursue the chase where there is less resistance and danger. However, when the wild boar is come to a state of maturity, and when conscious of his own superior strength, he then walks the forest alone and fearless. At that time he dreads no single creature, nor does he turn out of his way even for man himself. He does not seek danger, and he does not much seem to avoid it.

* Buffon, vol ix p 147

This animal is therefore seldom attacked but at a disadvantage either by numbers or when found sleeping by moon light. The hunting the wild boar is one of the principal amusements of the nobility in those countries where it is to be found. The dogs provided for this sport are of the slow heavy kind. Those used for hunting the stag or the roe buck would be very improper as they would too soon come up with their prey and instead of a chase would only furnish out an engagement. A small mastiff is therefore chosen nor are the hunters much mindful of the goodness of their nose as the wild boar leaves so strong a scent, that it is impossible for them to mistake its course. They never hunt any but the largest and the oldest which are known by their tricks. When the boar is *reared* as is the expression for driving him from his covert he goes slowly and uniformly forward not much afraid nor very far before his pursuers. At the end of every half mile or thereabouts he turns round stops till the hounds come up and offers to attack them. These on the other hand knowing their danger keep off and bay him at a distance. After they have for a while grazed upon each other with mutual animosity the boar again slowly goes on his course and the dogs renew their pursuit. In this manner the charge is sustained and the chase continues till the boar is quite tired and refuses to go any further. The dogs then attempt to close in upon him from behind those which are young fierce and unaccustomed to the chase are generally the foremost, and often lose their lives by their ardour. Those which are older and better trained are content to wait until the hunters come up who strike at him with their spears and after several blows dispatch or disable him. The instant the animal is killed they cut off the testicles which would otherwise give a taint to the flesh and the huntsmen celebrate the victory with their horns.

THE HOG

In a natural state is found to feed chiefly upon roots and vegetables it seldom attacks any other animal being content with such provisions as it procures without danger. Whatever animal happens to die in the forest or is so wounded that it can make no resistance becomes a prey

to the hog, who seldom refuses animal food, how putrid soever, although it is never at the pains of taking or procuring it alive. For this reason, it seems a glutton rather by accident than choice, content with vegetable food, and only devouring flesh when pressed by necessity, and when it happens to offer. Indeed, if we behold the hog in its domestic state, it is the most sordid and brutal animal in nature *. The awkwardness of its form seems to influence its appetites; and all its sensations are as gross as its shapes are unsightly. It seems possessed only of an insatiable desire of eating, and it seems to make choice only of what other animals find the most offensive. But we ought to consider, that the hog with us is in an unnatural state, and that it is in a manner compelled to feed in this filthy manner, from wanting that proper nourishment which it finds in the forest. When in a state of wildness, it is of all other quadrupeds the most delicate in the choice of what vegetables it shall feed on, and rejects a greater number than any of the rest. The cow, for instance, as we are assured by Linnæus, eats two hundred and seventy-six plants, and rejects two hundred and eighteen, the goat eats four hundred and forty-nine, and rejects a hundred and twenty-six; the sheep eats three hundred and eighty-seven, and rejects a hundred and forty-one, the horse eats two hundred and sixty-two, and rejects two hundred and twelve, but the hog, more nice in its provision than any of the former, eats but seventy-two plants, and rejects a hundred and seventy-one. The indelicacy of this animal is, therefore, rather in our apprehensions than in its nature; since we find it makes a very distinguishing choice in the quality of its food, and if it does not reject animal putrefaction, it may be because it is abridged in that food which is most wholesome and agreeable to it in a state of nature. This is certain, that its palate is not insensible to the difference of eatables, for, where it finds variety, it will reject the worst with as distinguishing a taste as any other quadruped whatsoever †. In the orchards of peach-trees in North America, where the hog has plenty of delicious

* Buffon, vol ix p 14

† British Zoology, vol 1 p. 42

food it is observed that it will reject the fruit that has lain but a few hours on the ground and continue on the watch whole hours together for a fresh wind fall

However the hog is naturally formed in a more imperfect manner than the other animals that we have rendered domestic around us less active in its motions less furnished with instinct in knowing what to pursue or avoid Without attachment and incapable of instruction it continues while it lives an useless or rather a rapacious dependent The coarseness of its hair and the thickness of its hide together with the thick coat of fat that lies immediately under the skin render it insensible to blows or rough usage Mice have been known to burrow in the back of these animals while sitting in the sty * without their seeming to perceive it Their other senses seem to be in tolerable perfection they scent the hounds at a distance, and as we have seen they are not insensible in the choice of their provisions

The hog is by nature stupid inactive and drowsy if undisturbed it would sleep half its time but it is frequently awaked by the calls of appetite which when it has satisfied it goes to rest again Its whole life is thus a round of sleep and gluttony and if supplied with sufficient food it soon grows unfit even for its own existence its flesh becomes a greater load than its legs are able to support and it continues to feed lying down or kneeling a helpless instance of indulged sensuality The only times it seems to have passions of a more active nature are when it is incited by venery or when the wind blows with any vehemence Upon this occasion it is so agitated as to run violently towards its sty screaming horribly at the same time which seems to argue that it is naturally fond of a warm climate It appears also to foresee the approach of bad weather bringing straw to its sty in its mouth preparing a bed and hiding itself from the impending storm Nor is it less agitated when it hears any of its kind in distress when a hog is caught in a gate as is often the case or when it suffers any of the usual domestic operations of ringing or sprying all the rest are then seen to gather round it to lend their fruitless assistance and to sympathize with its sufferings They have often also been

known to gather round a dog that had teased them, and kill him upon the spot

Most of the diseases of this animal arise from intemperance; measles, imposthumes, and scrofulous swellings, are reckoned among the number. It is thought by some that they wallow in the mire to destroy a sort of louse, or insect, that is often found to infest them, however, they are generally known to live, when so permitted, to eighteen or twenty years, and the females produce till the age of fifteen. As they produce from ten to twenty young at a litter, and that twice a year, we may easily compute how numerous they would shortly become, if not diminished by human industry. In the wild state they are less prolific; and the sow of the woods brings forth but once a year, probably because exhausted by rearing up her former numerous progeny.

It would be superfluous to dwell longer upon the nature and qualities of an animal too well known to need a description. There are few, even in cities, who are unacquainted with its uses, its appetites, and way of living. The arts of fattening, rearing, guarding, and managing hogs, fall more properly under the cognizance of the farmer than the naturalist, they make a branch of domestic economy, which, properly treated, may be extended to a great length, but the history of nature ought always to end where that of art begins. It will be sufficient, therefore, to observe, that the wild boar was formerly a native of our country, as appears from the laws of Hoel Dda,* the famous Welch legislator, who permitted his grand huntsman to chase that animal from the middle of November to the beginning of December. William the Conqueror also punished such as were convicted of killing the wild boar in his forests, with the loss of their eyes. At present, the whole wild breed is extinct, but no country makes greater use of the tame kinds, as their flesh, which bears salt better than that of any other animal, makes a principal part of the provisions of the British navy.

As this animal is a native of almost every country, there are some varieties found in the species. That which we call the East India breed, is lower, less furnished with hair, is

* British Zoology, vol i p 41

usually black and has the belly almost touching the ground it is now common in England it fattens more easily than the ordinary kind and makes better bacon

There is a remarkable variety of this animal about Upsal * which is single hoofed like the horse, but in no other respect differing from the common kind. The authority of Aristotle who first made mention of this kind has been often called in question, some have asserted that such a quadruped never existed because it happened not to fall within the sphere of their own confined observation however at present the animal is too well known to admit of any doubt concerning it. The hog common in Guinea differs also in some things from our own though striped exactly as ours it is of a reddish colour with long ears which end in a sharp point and a tail which hangs down to the pertern the whole body is covered with short red shining hair without any bristles but pretty long near the tail. Their flesh is said to be excellent and they are very tame

All these from their near resemblance to the hog may be considered as of the same species the East Indian hog we well know breeds with the common kind whether the same obtains between it and those of Upsal and Guinea we cannot directly affirm but where the external similitude is so strong we may be induced to believe that the appetites and habits are the same. It is true we are told that the Guinea breed will not mix with ours but keep separate and herd only together however this is no proof of their diversity since every animal will prefer its own likeness in its mate and they will only then mix with another sort when deprived of the society of their own. These therefore, we may consider as all of the hog kind but there are other quadrupeds that in general resemble this species which nevertheless are very distinct from them. Travellers indeed from their general form or from their habits and way of living have been content to call these creatures hogs also but upon a closer inspection their differences are found to be such as entirely to separate the kinds and make each a distinct animal by itself

CHAP II.

THE PECCARY, OR TAJACU

THAT animal which of all others most resembles the hog, and yet is of a formation very distinct from it, is called the *peccary*, or *tajacu*. It is a native of America, and found there in such numbers, that they are seen in herds of several hundreds together, grazing among the woods, and inoffensive, except when offended

The peccary, at first view, resembles a small hog, the form of its body, the shape of its head, the length of its snout, and the form of its legs, are entirely alike however, when we come to examine it nearer, the differences begin to appear. The body is not so bulky, its legs not so long, its bristles much thicker and stronger than those of the hog, resembling rather the quills of a porcupine than hair; instead of a tail, it has only a little fleshy protuberance, which does not even cover its posteriors; but that which is still more extraordinary, and in which it differs from all other quadrupeds whatsoever, is, that it has got upon its back a lump, resembling the navel in other animals, which is found to separate a liquor of a very strong smell. The peccary is the only creature that has those kind of glands which discharge the musky substance on that part of its body. Some have them under the belly, and others under the tail, but this creature, by a conformation peculiar to itself, has them on its back. This lump, or navel, is situated on that part of the back which is over the hinder legs, it is, in general, so covered with long bristles, that it cannot be seen, except they be drawn aside. A small space then appears, that is almost bare, and only beset with a few short fine hairs. In the middle it rises like a lump, and in this there is an orifice, into which one may thrust a common goose-quill. This hole or bag is not above an inch in depth; and round it, under the skin, are situated a number of small glands, which distil a whitish liquor, in colour and substance resembling that obtained from the civet animal. Perhaps it was this analogy, that led Dr Tyson to say, that it smelt agreeably also, like that perfume. But this Mr Buffon absolutely

denies affirming that the smell is at every time and in every proportion strong and offensive and to this I can add my own testimony if that able naturalist should want a voucher

But to be more particular in the description of the other parts of this quadruped the colour of the body is grizly and beset with bristles thicker and stronger than those of a common hog though not near so thick as those of a porcupine they resemble them in this respect, that they are variegated with black and white rings The belly is almost bare and the short bristles on the sides gradually increase in length as they approach the ridge of the back where some are five inches long On the head also between the ears there is a large tuft of bristles that are chiefly black The ears are about two inches and a half long and stand upright and the eyes resemble those of a common hog only they are smaller From the lower corner of the eye to the snout is usually six inches and the snout itself is like that of a hog though it is but small One side of the lower lip is generally smooth by the rubbing of the tusk of the upper jaw The feet and hoofs are perfectly like those of a common hog but as was already observed it has no tail There are some anatomical differences in its internal structure from that of the common hog Dr Lyson was led to suppose that it had three stomachs whereas the hog has but one however in this he was deceived as Mr Dauberton has plainly shewn that the stomach is only divided by two closings which gives it the appearance as if divided into three and there is no conformation that prevents the food in any part of it from going or returning to any other

The peccary may be tamed like the hog and has pretty nearly the same habits and natural inclinations It feeds upon the same aliments its flesh though drier and leaner than that of the hog is pretty good eating it is improved by castration and when killed not only the parts of generation must be taken instantly away but also the navel on the back with all the glands that contribute to its supply If this operation be deferred for only half an hour the flesh becomes utterly unfit to be eaten

The peccary is extremely numerous in all the parts of Southern America They go in herds of two or three hun

dred together ; and unite, like hogs, in each other's defence. They are particularly fierce when their young are attempted to be taken from them. They surround the plunderer, attack him without fear, and frequently make his life pay the forfeit of his rashness. When any of the natives are pursued by a herd in this manner, they frequently climb a tree to avoid them ; while the peccaries gather round the root, threaten with their tusks, and then rough bristles standing erect, as in the hog kind, they assume a very terrible appearance. In this manner they remain at the foot of the tree for hours together, while the hunter is obliged to wait patiently, and not without apprehensions, until they think fit to retire.

The peccary is rather fond of the mountainous parts of the country, than the lowlands ; it seems to delight neither in the marshes nor the mud, like our hogs, it keeps among the woods, where it subsists upon wild fruits, roots, and vegetables, it is also an unceasing enemy to the lizard, the toad, and all the serpent kinds, with which these uncultivated forests abound. As soon as it perceives a serpent, or a viper, it at once seizes it with its fore hoofs and teeth, skins it in an instant, and devours the flesh. This is often seen, and may therefore be readily credited, but as to its applying to a proper vegetable immediately after, as an antidote to the poison of the animal it had devoured, this part of the relation we may very well suspect. The flesh neither of the toad nor viper, as every one now knows, are poisonous ; and, therefore, there is no need of a remedy against their venom. Ray gives no credit to either part of the account ; however, we can have no reason to disbelieve that it feeds upon toads and serpents ; it is only the making use of a vegetable antidote that appears improbable, and which perhaps had its rise in the ignorance and credulity of the natives.

The peccary, like the hog, is very prolific, the young ones follow the dam, and do not separate till they have come to perfection. If taken at first, they are very easily tamed, and soon lose all their natural ferocity, however, they never shew any remarkable signs of docility, but continue stupid and rude, without attachment, or even seeming to know the hand that feeds them. They only continue to do no mischief ; and they may be permitted to run tame, without apprehend-

ing any dangerous consequences. They seldom stray far from home they return of themselves to the sty and do not quarrel among each other except when they happen to be fed in common. At such times they have an angry kind of growl much stronger and harsher than that of a hog but they are seldom heard to scream as the former only now and then when frightened or irritated they have an abrupt angry manner of blowing like the boar.

The peccary though like the hog in so many various respects is nevertheless a very distinct race and will not mix nor produce an intermediate breed. The European hog has been transplanted into America and suffered to run wild among the woods it is often seen to herd among a drove of peccaries but never to breed from them. They may therefore be considered as two distinct creatures the hog is the larger and the more useful animal the peccary more feeble and local the hog subsists in most parts of the world and in almost every climate the peccary is a native of the warmer regions and cannot subsist in ours without shelter and assistance. It is more than probable however that we could readily propagate the breed of this quadruped and that in two or three generations it might be familiarized to our climate but as it is inferior to the hog in every respect so it would be needless to admit a new domestic whose services are better supplied in the old.

CHAP. III.

THE CAPIBARA OR CABAIA

THERE are some quadrupeds so entirely different from any that we are acquainted with that it is hard to find a well known animal to which to resemble them. In this case we must be content to place them near such as they most approach in form and habits so that the reader may at once have some idea of the creature's shape or disposition although perhaps an inadequate and a very confused one.

Upon that confused idea however it will be our business to work to bring it by degrees to greater precision to mark out the differences of form and thus give the

clearest notions that words can easily convey The known animal is a kind of rude sketch of the figure we want to exhibit, from which, by degrees, we fashion out the shape of the creature we desire should be known; as a statuary seldom begins his work, till the rude outline of the figure is given by some other hand.—In this manner, I have placed the capibara among the hog kind, merely because it is more like a hog than any other animal commonly known, and yet, more closely examined, it will be found to differ in some of the most obvious particulars.

The capibara resembles a hog of about two years old, in the shape of its body, and the coarseness and colour of its hair Like the hog, it has a thick short neck, and a rounded bristly back, like the hog, it is fond of the water and marshy places, brings forth many at a time, and like it feeds upon animal and vegetable food But when examined more nearly, the differences are many and obvious The head is longer, the eyes are larger, and the snout, instead of being rounded, as in the hog, is split like that of a rabbit or hare, and furnished with thick strong whiskers, the mouth is not so wide, the number and the form of the teeth are different, for it is without tusks like the peccary, it wants a tail; and, unlike to all others of this kind, instead of a cloven hoof, it is in a manner web-footed, and thus entirely fitted for swimming, and living, in the water The hoofs before are divided into four parts; and those behind into three, between the divisions, there is a prolongation of the skin, so that the foot, when spread in swimming, can beat a greater surface of water

As its feet are thus made for the water, so it is seen to delight entirely in that element; and some naturalists have called it the *water-hog* for that reason It is a native of South America, and is chiefly seen frequenting the borders of lakes and rivers, like the otter. It seizes the fish, upon which it preys, with its hoofs and teeth, and carries them to the edge of the lake, to devour them at its ease It lives also upon fruits, corn, and sugar-canes As its legs are long and broad, it is often seen sitting up like a dog that is taught to beg Its cry more nearly resembles the braying of an ass, than the grunting of a hog It seldom goes out, except at night, and that always in company. It never ventures far from the sides of the river or the lake in which it preys; for

as it runs ill because of the length of its feet and the shortness of its legs so its only place of safety is the water into which it immediately plunges when pursued and keeps so long at the bottom that the hunter can have no hopes of taking it there. The capibara even in a state of wildness is of a gentle nature and when taken young is easily tamed. It comes and goes at command and even shews an attachment to its keeper. Its flesh is said to be fat and tender, but from the nature of its food it has a fishy taste like that of all those which are bred in the water. Its head however is said to be excellent and in this it resembles the beaver whose fore parts taste like flesh and the hinder like the fish it feeds on.

CHAP. IV

OF BABYROUESA OR INDIAN HOG

THE Babyroessa is still more remote from the hog kind than the capibara and yet most travellers who have described this animal do not scruple to call it the hog of Borneo which is an island in the East Indies where it is principally to be found. Probably this animal's figure upon the whole most resembles that of the hog kind and may have induced them to rank it among the number however when they come to its description they represent it as having neither the hair the bristles the head the stature nor the tail of a hog. Its legs we are told are longer its snout shorter its body more slender and somewhat resembling that of a stag its hair is finer of a gray colour rather resembling wool than bristles and its tail also tufted with the same. From these varieties therefore it can scarcely be called a hog and yet in this class we must be content to rank it until its form and nature come to be better known. What we at present principally distinguish it by are four enormous tusks that grow out of the jaws the two largest from the upper and the two smallest from the under. The jaw bones of this extraordinary animal are found to be very thick and strong from whence these monstrous tusks are seen to proceed that distinguish it from all other quadrupeds whatsoever. The two

that go from the lower jaw are not above a foot long, but those of the upper are above half a yard, as in the boar, they bend circularly, and the two lower stand in the jaw as they are seen to do in that animal, but the two upper rise from the upper jaw, rather like horns than teeth; and, bending upwards and backwards, sometimes have their points directed to the animal's eyes, and are often fatal by growing into them. Were it not that the babiroussa has two such large teeth underneath, we might easily suppose the two upper to be horns; and, in fact, their sockets are directed upwards; for which reason, Dr. Grew was of that opinion. But as the teeth of both jaws are of the same consistence, and as they both grow out of sockets in the same manner, the analogy between both is too strong not to suppose them of the same nature. The upper teeth, when they leave the socket, immediately pierce the upper lips of the animal, and grow as if they immediately went from its cheek. The tusks in both jaws are of a very fine ivory, smoother and whiter than that of the elephant, but not so hard or serviceable.

These enormous tusks give this animal a very formidable appearance; and yet it is thought to be much less dangerous than the wild boar*. Like animals of the hog kind, they go together in a body, and are often seen in company with the wild boar, with which, however, they are never known to engender. They have a very strong scent, which discovers them to the hounds, and when pursued they grow dreadfully, often turning back upon the dogs, and wounding them with the tusks of the lower jaw, for those of the upper are rather an obstruction than a defence. They run much swifter than the boar, and have a more exquisite scent, winding the men and the dogs at a great distance. When hunted closely, they generally plunge themselves into the sea, where they swim with great swiftness and facility, diving and rising again at pleasure, and in this manner they most frequently escape their pursuers. Although fierce and terrible when offended, yet they are peaceable and harmless when unmolested. They are easily tamed, and their flesh is good to be eaten, but it is said to putrefy in a very short time. They have a way of reposing themselves different from most other animals of the larger kind, which is by hitching one of their upper tusks on the branch of a tree, and then suffering their whole body

* Buffon, vol. xlv p 179

to swing down at ease. Thus suspended from a tooth they continue the whole night quite secure and out of the reach of such animals as hunt them for prey.

The bristleness though by its teeth and tusks it seems fitted for a state of hostility and probably is carnivorous yet nevertheless seems chiefly to live upon vegetables and the leaves of trees. It seldom seeks to break into gardens like the boar in order to pillage the more succulent productions of human industry but lives remote from mankind content with coarser fare and security. It has been said that it was only to be found in the island of Borneo but this is a mistake as it is well known in many other parts both of Asia and Africa as at the Celebes at Isthm Senegal and Madagascar*.

Such are the animals of the hog kind which are not distinctly known and even all these as we see have been but imperfectly examined or described. There are some others of which we have still more imperfect notices such as the warree a hog of the Isthmus of Darien described by Wafer with large tusks small ears and bristles like a coarse fur all over the body. This however may be the European hog which has run wild in that part of the new world as no other traveller has taken notice of the same. The Canary boar seems different from other animals of this kind by the largeness of its tusks and as is judged from the skeleton by the aperture of its nostrils and the number of its grinders. I can not conclude this account of those animals that are thus furnished with enormous tusks without observing that there is a strong consent between these and the parts of generation. When castrated it is well known that the tusks grow much smaller and are scarcely seen to appear without the lips but what is still more remarkable is that in a boar if the tusks by any accident or design be broken away the animal abates of its fierceness and venery and it produces nearly the same effect upon its constitution as if castration had actually taken place †.

* Anderson's Natural History of Greenland

† Lisle's Husbandry vol. II p. 39

BOOK IV.

CARNIVOROUS ANIMALS

CHAP I.

ANIMALS OF THE CAT KIND *

WE have hitherto been describing a class of peaceful and harmless animals, that serve as the instruments of man's happiness, or, at least, that do not openly oppose him. We come now to a bloody and unrelenting tribe, that disdain to own his power, and carry on unceasing hostilities against him. All the class of the cat kind are chiefly distinguished by their sharp and formidable claws, which they can hide and extend at pleasure. They lead a solitary ravenous life, neither uniting for their mutual defence, like vegetable feeders, nor for their mutual support, like those of the dog kind. The whole of this cruel and ferocious tribe seek their food alone, and, except at certain seasons, are even enemies to each other. The dog, the wolf, and the bear, are sometimes known to live upon vegetables or farinaceous food; but all of the cat kind, such as the lion, the tiger, the leopard, and the ounce, devour nothing but flesh, and starve upon any other provision.

They are, in general, fierce, rapacious, subtle, and cruel, unfit for society among each other, and incapable of adding to human happiness. However, it is probable that even the fiercest could be rendered domestic, if man thought the conquest worth the trouble. Lions have been yoked to the chariots of conquerors, and tigers have been taught to tend those herds which they are known at present to destroy; but

* The quadrupeds of this family are distinguished by having six front teeth, the intermediate ones of which are equal, the grinders are three on each side in each jaw, the tongue is furnished with rough prickles pointing backwards, and the claws are sheathed and retractile, except in the lion, which has them retractile, but not sheathed.

these services are not sufficient to recompense for the trouble of their keeping, so that ceasing to be useful they continue to be noxious and become rebellious subjects because not taken under equal protection with the rest of the brute creation

Others tribes of animals are classed with difficulty have often but few points of resemblance and though alike in form have different dispositions and different appetites But all those of the cat kind although differing in size or in colour are yet nearly allied to each other, being equally fierce rapacious and artful and he that has seen one has seen all In other creatures there are many changes wrought by human assiduity the dog the hog or the sheep are altered in their natures and forms just as the necessities or the caprice of mankind have found fitting but all of this kind are inflexible in their forms and wear the print of their natural wildness strong upon them The dogs or cows vary in different countries but lions or tigers are still found the same the very colour is nearly alike in all and the slightest alterations are sufficient to make a difference in the kinds and to give the animal a different denomination

The cat kind are not less remarkable for the sharpness and strength of their claws which thrust forth from their sheath when they seize their prey than for the shortness of their snout the roundness of their head and the large whiskers which grow on the upper lip Their teeth also which amount to the number of thirty are very formidable but rather calculated for tearing their prey than for chewing it for this reason they feed but slowly and while they eat generally continue growling to deter others from taking a share In the dog kind the chief power lies in the under jaw which is long and furnished with muscles of amazing strength but in these the greatest force lies in the claws which are extended with great ease and their gripe is so tenacious that nothing can open it The hinder parts in all these animals are much weaker than those before, and they seem less made for strength than agility Nor are they endued with the swiftness of most other animals but generally owe their subsistence rather to catching their prey by surprise than by hunting it furly down They all seize it with a bound at the same time expressing their fierce pleasure with a roar and the first grasp generally disables the

captive from all further resistance. With all these qualifications for slaughter, they, nevertheless, seem timid and cowardly, and seldom make an attack, like those of the dog kind, at a disadvantage: on the contrary, they fly when the force against them is superior, or even equal to their own; and the lion himself will not venture to make a second attempt, where he has once been repulsed with success. For this reason, in countries that are tolerably inhabited, the lion is so cowardly, that he is often scared away by the cries of women and children.

The cat, which is the smallest animal of this kind, is the only one that has been taken under human protection, and may be considered as a faithless friend, brought to oppose a still more insidious enemy *. It is, in fact, the only animal of this tribe whose services can more than recompense the trouble of their education, and whose strength is not sufficient to make its anger formidable. The lion, or the tiger, may easily be tamed, and rendered subservient to human command; but even in their humblest, and most familiar moments, they are still dangerous, since their strength is such, that the smallest fit of anger or caprice may have dreadful consequences. But the cat, though easily offended, and often capricious in her resentments, is not endowed with powers sufficient to do any great mischief. Of all animals, when young, there is none more prettily playful than the kitten; but it seems to lose this disposition as it grows old, and the innate treachery of its kind is then seen to prevail. From being naturally ravenous, education teaches it to disguise its appetites, and to watch the favourable moment of plunder, supple, insinuating, and artful, it has learned the arts of concealing its intentions till it can put them into execution, when the opportunity offers, it at once seizes upon whatever it finds, flies off with it, and continues at a distance till it supposes its offence forgotten. The cat has only the appearance of attachment, and it may easily be perceived, by its timid approaches, and side-long looks, that it either dreads its master, or distrusts his kindness, different from the dog, whose caresses are sincere, the cat is assiduous rather for its own pleasure, than to please, and often gains confidence only to

* This description is nearly translated from Mr Buffon what I have added is marked with inverted commas

abuse it. The form of its body and its temperament correspond with its disposition, active cleanly delicate and voluptuous it loves its ease and seeks the softest cushions to lie on. Many of its habits however are rather the consequences of its formation than the result of any perverseness in its disposition. It is timid and mistrustful because its body is weak and its skin tender, a blow hurts it infinitely more than it does a dog whose hide is thick and body muscular, the long fur in which the cat is clothed entirely disguises its shape which if seen naked is long flexible and slender. It is not to be wondered therefore that it appears much more fearful of chastisement than the dog and often flus even when no correction is intended. Being also a native of the warmer climates as will be shewn hereafter it chooses the softest bed to lie on, which is always the warmest.

The cat goes with young fifty six days and seldom brings forth above five or six at a time. The female usually hides the place of her retreat from the male who is often found to devour her kittens. She feeds them for some weeks with her milk and whatever small animals she can take by surprise accustoming them betimes to rapine. Before they are a year old they are fit to engender the female seeks the male with cries nor is their copulation performed without great pain from the narrowness of the passage in the female. They live to about the age of ten years and during that period they are extremely vicious suffering to be worried a long time before they die.

The young kittens are very playful and amusing but their sport soon turns into malice and they from the beginning shew a disposition to cruelty they often look wistfully towards the cage sit continually at the mouth of a mouse hole and in a short time become more expert hunters than if they had received the instructions of art. Indeed their disposition is so incapable of constraint that all instruction would be but thrown away. It is true that we are told of the Greek monks of the isle of Cyprus teaching cats to hunt the serpents with which the island is infested but this may be natural to the animal itself and they might have fallen upon such a pursuit without any instruction. Whatever animal is much weaker than themselves is to them an indiscriminate object of destruc-

tion. Birds, young rabbits, hares, rats, and mice, bats, moles, toads, and frogs, are all equally pursued; though not, perhaps, equally acceptable. The mouse seems to be their favourite game; and, although the cat has the sense of smelling in but a mean degree, it, nevertheless, knows those holes in which its prey resides. I have seen one of them patiently watch a whole day until the mouse appeared, and continue quite motionless until it came within reach, and then seized it with a jump. Of all the marks by which the cat discovers its natural malignity, that of playing and sporting with its little captive, before killing it outright, is the most flagrant.

The fixed inclination which they discover for this peculiar manner of pursuit, arises from the conformation of their eyes. The pupil in man, and in most other animals, is capable but of a small degree of contraction and dilatation, it enlarges a little in the dark, and contracts when the light pours in upon it in too great quantities. In the eyes of cats, however, this contraction and dilatation of the pupil is so considerable, that the pupil, which by day-light appears narrow and small like the black of one's nail, by night expands over the whole surface of the eye-ball, and, as every one must have seen, their eyes seem on fire. By this peculiar conformation, their eyes see better in darkness than light; and the animal is thus better adapted for spying out and surprising its prey.

Although the cat is an inhabitant of our houses, yet it cannot properly be called a dependent, although perfectly tame, yet it acknowledges no obedience, on the contrary, it does only just what it thinks fit, and no art can control any of its inclinations. In general, it is but half tamed; and has its attachments rather to the place in which it resides, than to the inhabitant. If the inhabitant quits the house, the cat still remains, and if carried elsewhere, seems for a while bewildered with its new situation. It must take time to become acquainted with the holes and retreats in which its prey resides, with all the little labyrinths through which they often make good an escape.

The cat is particularly fearful of water, of cold, and of ill smells. It loves to keep in the sun, to get near the fire, and to rub itself against those who carry perfumes. It is excessively fond of some plants, such as valerian, marum,

and cat mint against these it rubs smells them at a distance and at last if they be planted in a garden wears them out

This animal eats slowly and with difficulty as its teeth are rather made for tearing than chewing its aliments For this reason it loves the most tender food particularly fish which it eats as well boiled as raw Its sleeping is very light and it often seems to sleep the better to deceive its prey When the cat walks it treads very softly and without the least noise and as to the necessities of nature it is cleanly to the last degree Its fur also is usually sleek and glossy and for this reason the hair is easily electrified sending forth shining sparks if rubbed in the dark

The wild cat breeds with the tame * and therefore the latter may be considered only as a variety of the former however they differ in some particulars the cat in its savage state is somewhat larger than the house cat and its fur being longer gives it a greater appearance than it really has its head is bigger and face flatter the teeth and claws much more formidable its muscles very strong as being formed for rapine the tail is of a moderate length but very thick and flat marked with alternate bars of black and white the end always black the hips and hind part of the lower joints of the leg are always black the fur is very soft and fine the general colour of these animals in England is a yellowish white mixed with a deep gray These colours though they appear at first sight confusedly blended together yet on a close inspection will be found to be disposed like the streaks on the skin of the tiger pointing from the back downwards rising from a black list that runs from the head along the middle of the back to the tail This animal is found in our larger woods and is the most destructive of the carnivorous kinds in this kingdom It inhabits the most mountainous and woody parts of these islands living mostly in trees and feeding only by night It often happens that the females of the tame kind go into the woods to seek mates among the wild ones It should seem that these however are not original inhabitants of this kingdom but were introduced first in a domestic state and afterwards became wild in the woods by

* British Zoology

ill usage or neglect. Certain it is, the cat was an animal much higher in esteem among our ancestors than it is at present. By the laws of Howel, the price of a kitten, before it could see, was to be a penny; till it caught a mouse, two-pence; and when it commenced mouser, four-pence. it was required, besides, that it should be perfect in its senses of hearing and seeing, be a good mouser, have the claws whole, and be a good nurse. If it failed in any of these qualities, the seller was to forfeit to the buyer the third part of its value. If any one stole or killed the cat that guarded the prince's granary, he was to forfeit a milch ewe, its fleece and lamb, or as much wheat as when poured on the cat, suspended by the tail, (the head touching the floor,) would form a heap high enough to cover the tip of the former. From hence we discover, besides a picture of the simplicity of the times, a strong argument that cats were not naturally bred in our forests. An animal that could have been so easily taken, could never have been rated so highly, and the precautions laid down to improve the breed, would have been superfluous, in a creature that multiplies to such an amazing degree.

“In our climate, we know but of one variety of the wild cat, and, from the accounts of travellers, we learn, that there are but very few differences in this quadruped in all parts of the world. The greatest difference, indeed, between the wild and the tame cat, is rather to be found internally than in their outward form. Of all other quadrupeds, the wild cat is, perhaps, that whose intestines are proportionably the smallest and the shortest. The intestines of the sheep, for instance, unravelled out, and measured according to their length, will be found to be above thirty times the length of its body, whereas the wild cat's intestines being measured out, will not be found above three times the length of its body. This is a surprising difference, but we may account for it, from the nature of the food in the two animals. the one living upon vegetables, which require a longer, and a more tedious preparation, before they can become a part of its body, the other living upon flesh, which requires very little alteration, in order to be assimilated into the substance of the creature that feeds upon it. The one, therefore, wanted a long canal for properly digesting and straining its food;

the other but a short one as the food is already prepared to pass the usual secretions however a difficulty still remains behind, the intestines of the wild cat are by one third shorter than those of the tame. How can we account for this? If we say that the domestic cat living upon more nourishing and more plentiful provision has its intestines enlarged to the quantity with which it is supplied we shall find this observation contradicted in the wild boar and the wolf whose intestines are as long as those of the hog or the dog though they lead a savage life and like the wild cat are fed by precarious subsistence. The shortness therefore of the wild cat's intestines is still unaccounted for and most naturalists consider the difficulty as inexplicable. We must leave it therefore as one of those difficulties which future observation or accident are most likely to discover.

This animal is one of those few which are common to the new continent as well as the old. When Christopher Columbus first discovered that country a hunter brought him one which he had discovered in the woods. It was of the ordinary size the tail very long and thick. They were common also in Peru although they were not rendered domestic. They are well known also in several parts of Africa and many parts of Asia. In some of these countries they are of a peculiar colour and inclining to blue. In Persia Pietro della Valle informs us that there is a kind of cat particularly in the province of Chorizan of the figure and form of the ordinary one but infinitely more beautiful in the lustre and colour of its skin. It is of a grey blue without mixture and as soft and shining as silk. The tail is very long and covered with hair six inches long which the animal throws upon its back like the squirrel. These cats are well known in France and have been brought over into England under the name of the *blue cat* which however is not their colour.

Another variety of this animal is called by us the *lion cat* or as others more properly term it the *cat of Angora*. These are larger than the common cat and even than the wild one. Their hair is much longer and hangs about their head and neck giving this creature the appearance of a lion. Some of these are white and others of a dun colour. These come from Syria and Persia two countries which

are noted for giving a long soft hair to the animals which are bred in them. The sheep, the goats, the dogs, and the rabbits, of Syria, are all remarkable for the fine glossy length and softness of their hair; but particularly the cat, whose nature seems to be so inflexible, conforms to the nature of the climate and soil, loses its savage colour, which it preserves almost in every other part of the world, and assumes the most beautiful appearance. There are some other varieties in this animal, but rather in colour than in form; and, in general, it may be remarked, that the cat, when carried into other countries, alters but very little, still preserving its natural manners, habits, and conformation.

THE LION

THE influence of climate upon mankind is very small,* he is found to subsist in all parts of the earth, as well under the frozen poles, as beneath the torrid zone, but in animals, the climate may be considered as congenial, and a kind of second nature. They almost all have their particular latitudes, beyond which they are unable to subsist; either perishing with a moderate cold, or dying for want of a frozen air, even in a temperate climate. The rein-deer is never seen to depart from the icy fields of the north, and, on the contrary, the lion degenerates, when taken from beneath the line. The whole earth is the native country of man, but all inferior animals have each their own peculiar districts.

Most terrestrial animals are found larger, fiercer, and stronger, in the warm, than in the cold or temperate climates. They are also more courageous and enterprising; all their dispositions seeming to partake of the ardour of their native soil. The lion produced under the burning sun of Africa, is of all others the most terrible, the most undaunted. The wolf or the dog, instead of attempting to rival him, scarce deserve to attend his motions, or become his providers. Such, however, of these animals, as are bred in a more temperate climate, or towards the tops of cold and lofty mountains, are far more gentle, or, to speak

* This description is principally taken from Mr Buffon. such parts as are added from others, I have marked with inverted commas

more properly far less dangerous than those bred in the torrid valleys beneath. The lions of Mount Atlas the tops of which are covered in eternal snows have neither the strength nor the ferocity of the lions of Bildulgerid or Zarr where the plains are covered with burning sands. It is particularly in these frightful deserts that those enormous and terrible beasts are found that seem to be the scourge and the terror of the neighbouring kingdoms. Happily indeed the species is not very numerous and it seems to be diminishing daily for those who have travelled through these countries assure us, that there are by no means so many there at present as were known formerly and Mr Shaw observes that the Romans carried fifty times as many lions from Libya in one year to combat in their amphitheatres as are to be found in the whole country at this time. The same remark is made with regard to Turkey to Persia and the Indies where the lions are found to diminish in their numbers every day. Nor is it difficult to assign the cause of this diminution it is obvious that it cannot be owing to the increase of the force of other quadrupeds since they are all inferior to the lion and consequently instead of lessening the number only tend to increase the supplies on which they subsist it must therefore be occasioned by the increase of mankind who is the only animal in nature capable of making head against these tyrants of the forest and preventing their increase. The arms even of a Hottentot or a Negro make them more than a match for this powerful creature and they seldom make the attack without coming off victorious. Their usual manner is to find out his retreat, and with spears headed with iron to provoke him to the combat four men are considered as sufficient for this encounter and he against whom the lion flies receives him upon his spear while the others attack him behind the lion finding himself wounded in the rear turns that way and thus gives the man he first attacked an opportunity to recover. In this manner they attack him on all sides until at last they entirely disable and then dispatch him. This superiority in the numbers and the arts of man that are sufficient to conquer the lion serve also to enervate and discourage him for he is brave only in proportion to the success of his former encounters.

In the vast deserts of Zaara, in the burning sands that lie between Mauritania and Negioland, in the uninhabited countries that lie to the north of Caffaria, and, in general, in all the deserts of Africa, where man has not fixed his habitation, the lions are found in great numbers, and preserve their natural courage and force. Accustomed to measure their strength with every animal they meet, the habit of conquering renders them intrepid and terrible. Having never experienced the dangerous arts and combinations of man, they have no apprehensions from his power. They boldly face him, and seem to brave the force of his arms. Wounds rather serve to provoke their rage, than repress their ardour. They are not daunted even with the opposition of numbers, a single lion of the desert often attacks an entire caravan, and, after an obstinate combat, when he finds himself overpowered, instead of flying, he continues to combat, retreating, and still facing the enemy till he dies. On the contrary, the lions which inhabit the peopled countries of Morocco or India, having become acquainted with human power, and experienced man's superiority, have lost all their courage, so as to be scared away with a shout, and seldom attack any but the unresisting flocks or herds, which even women and children are sufficient to protect.

This alteration in the lion's disposition sufficiently shews that he might easily be tamed, and admit of a certain degree of education. "In fact, nothing is more common than for the keepers of wild beasts to play with this animal, to pull out his tongue, and even to chastise him without a cause. He seems to bear it all with the utmost composure, and we very rarely have instances of his revenging these unprovoked sallies of impertinent cruelty. However, when his anger is at last excited, the consequences are terrible. Labat tells us of a gentleman who kept a lion in his chamber, and employed a servant to attend it, who, as is usual, mixed his blows with caresses. This ill-judged association continued for some time, till one morning the gentleman was awakened by a noise in his room, which, at first, he could not tell the cause of, but, drawing the curtains, he perceived a horrid spectacle; the lion growling over the man's head, which he had separated from the body, and tossing it round the floor. He

immediately therefore flew into the next room called to the people without, and had the animal secured from doing further mischief. However this single account is not sufficient to weigh against the many instances we every day see of this creature's gentleness and submission. He is often bred up with other domestic animals and is seen to play innocently and familiarly among them and if ever it happens that his natural ferocity returns it is seldom exerted against his benefactors. As his passions are strong and his appetites vehement one ought not to presume that the impressions of education will always prevail so that it would be dangerous in such circumstances to suffer him to remain too long without food or to persist in irritating and abusing him. However numberless accounts assure us that his anger is noble his courage magnanimous and his disposition grateful. He has been often seen to despise contemptible enemies and pardon their insults when it was in his power to punish them. He has been seen to spare the lives of such as were thrown to be devoured by him to live peaceably with them to afford them a part of his subsistence and sometimes to want food himself rather than deprive them of that life which his generosity had spared.

It may also be said that the lion is not cruel since he is so only from necessity and never kills more than he consumes. When satiated he is perfectly gentle while the tiger the wolf and all the inferior kinds such as the fox the pole cat and the ferret kill without remorse are fierce without cause and by their indiscriminate slaughter seem rather to satisfy their malignity than their hunger.

The outward form of the lion seems to speak his internal generosity. His figure is striking his look confident and bold his gait proud and his voice terrible. His stature is not overgrown like that of the elephant or rhinoceros nor is his shape clumsy like that of the hippopotamos or the ox. It is compact well proportioned and sizeable a perfect model of strength joined with agility. It is muscular and bold neither charged with fat nor unnecessary flesh. It is sufficient but to see him in order to be assured of his superior force. His large head surrounded with a dreadful mane all those muscles that appear under the skin swelling with the slightest exertions and the great

breadth of his paws, with the thickness of his limbs, plainly evince that no other animal in the forest is capable of opposing it. He has a very broad face, that, as some have imagined, resembles the human. It is surrounded with very long hair, which gives it a very majestic air. The top of the head, the temples, the cheeks, the under-jaw, the neck, the breast, the shoulder, the hinder part of the legs, and the belly, are furnished with it, while all the rest of the body is covered with very short hair, of a tawny colour. "The length of the hair in many parts, and the shortness of it in others, serves a good deal to disguise this animal's real figure. The breast, for instance, appears very broad, but in reality it is as narrow and contracted in proportion as that of the generality of dogs and horses. For the same reason, the tail seems to be of an equal thickness from one end to the other, on account of the inequality of the hair with which it is encompassed; it being shorter near the insertion, where the flesh and bones are large, and growing longer in proportion as its real thickness lessens towards the point, where it ends in a tuft. The hair about the neck and the breast is not different from that on the rest of the body, except in the length of it, nor is each hair pointed, as in most other animals, but of an equal thickness from one end to the other. The neck is very strong, but not composed of one solid bone; as Aristotle has imagined, on the contrary, though very short and muscular, it has as many bones as the camel or the horse, for it is universal to all quadrupeds to have seven joints in the neck; and not one of them have either more or less. However, the muscles in the neck of the lion, that tie the bones together, are extremely strong, and have somewhat the appearance of bones, so that ancient authors, who have treated of this animal, have mistaken the whole for a single bone. The tongue is rough, and beset with prickles as hard as a cat's claws; these have the grain turned backwards, so that it is probable a lion, if it should attempt to lick a man's hand, as we are told it sometimes does, would tear off the skin. The eyes are always bright and fiery; nor even in death does this terrible look forsake them. In short, the structure of the paws, teeth, eyes, and tongue, are the same as in a cat, and also in the inward parts these two animals so nearly

resemble each other that the anatomist's chief distinction arises merely from the size.

The lion has as was observed before a large mane which grows every year longer as the animal grows older the lioness is without this ornament at every age. This mane is not coarse or rough as in a horse but composed of the same hair with the rest of the body lengthened and shining. The mane as well as the rest of the body is of a yellow colour nor is there ever any difference to be found in the colour of one lion from that of another. What the ancients might have said concerning black lions or white or streaked like the tiger is not confirmed by modern experience so that these varieties have never been seen or exist no longer.

It is usually supposed that the lion is not possessed of the sense of smelling in such perfection as most other animals. It is also observed that too strong a light greatly incommodates him. This is more than probable from the formation of his eyes which like those of the cat seem fitted for seeing best in the dark. For this reason he seldom appears in open day but ravages chiefly by night and not only the lion but all other animals of the cat kind are kept off by the fires which the inhabitants light to preserve their herds and flocks the brightness of the flame dazzles their eyes which are only fitted for seeing in the dark and they are afraid to venture blindly into those places which they know to be filled with their enemies. It is equally true of all this kind that they hunt rather by the sight than the smell and it sometimes happens that the lion pursues either the jackal or the wild dog while they are hunting upon the scent and when they have run the beast down, he comes in and monopolizes the spoil. From hence probably may have arisen the story of the lion's provider these little industrious animals may often it is true provide a feast for the lion but they have hunted merely for themselves and he is an unwelcome intruder upon the fruits of their toil.

The lion when hungry boldly attacks all animals that come in his way but as he is very formidable and as they all seek to avoid him he is often obliged to hide in order to take them by surprise. For this purpose he crouches on his belly in some thicket or among the long grass which is

found in many parts of the forest; in this retreat he continues, with patient expectation, until his prey comes within a proper distance, and he then springs after it, fifteen or twenty feet from him, and often seizes it at the first bound. If he misses the effort, and in two or three reiterated springs cannot seize his prey, he continues motionless for a time, seems to be very sensible of his disappointment, and waits for a more successful opportunity. In the deserts and forests, his most usual prey are the gazelles and the monkeys, with which the torrid regions abound. The latter he takes when they happen to be upon the ground, for he cannot climb trees like the cat or the tiger. He devours a great deal at a time, and generally fills himself for two or three days to come. His teeth are so strong that he very easily breaks the bones, and swallows them with the rest of the body. It is reported that he sustains hunger a very long time, but that he cannot support in an equal degree, his temperament being extremely hot; some have even asserted that he is in a continual fever. He drinks as often as he meets with water, lapping it like a cat; which, as we know, drinks but slowly. He generally requires about fifteen pounds of raw flesh in a day, he prefers that of live animals, and particularly those which he has just killed. He seldom devours the bodies of animals when they begin to putrify, and he chooses rather to hunt for a fresh spoil, than to return to that which he had half devoured before. However, though he usually feeds upon fresh provision, his breath is very offensive, and his urine insupportable.

The roaring of the lion is so loud, that when it is heard in the night, and re-echoed by the mountains, it resembles distant thunder. This roar is his natural note; for when enraged he has a different growl, which is short, broken, and reiterated. The roar is a deep hollow growl, which he sends forth five or six times a day, particularly before rains. The cry of anger is much louder and more formidable. This is always excited by opposition; and upon those occasions, when the lion summons up all his terrors for the combat, nothing can be more terrible. He then lashes his sides with his long tail, which alone is strong enough to lay a man level. He moves his mane in every direction, it seems to rise and stand like bristles round his head, the skin and muscles of his face are all in agitation; his huge eye-brows

half cover his glaring eye balls he discovers his teeth which are formed rather for destruction than chewing his food he shows his tongue covered with points and extends his claws which appear almost as long as a man's fingers Prepared in this manner for war there are few animals that will venture to engage him and even the boldest of the human kind are daunted at his approach The elephant the rhinoceros the tiger and the hippopotamus are the only animals that are not afraid singly to make opposition

Nevertheless neither the leopard nor the wild boar if provoked will shun the combat they do not seek the lion to attack but will not fly at his approach they wait his onset which he seldom makes unless compelled by hunger they then exert all their strength and are sometimes successful We are told of the combat of a lion and a wild boar in a meadow near Algiers which continued for a long time with incredible obstinacy At last, both were seen to fall by the wounds they had given each other and the ground all about them was covered with their blood These instances however are very rare for the lion is in general the undisputed master of the forest Man is the only creature that attacks him with almost certain success with the assistance of dogs and horses which are trained to the pursuit These animals that in a state of nature would have fled from the presence of the lion in an agony of consternation when conscious of the assistance of man become pursuers in their turn and boldly hunt their natural tyrant The dogs are always of the large breed and the horses themselves as Gessner assures us must be of that sort called *charrossi* or lion eyed all others of this kind flying at the sight of the lion and endeavouring to throw their riders When the lion is roused he recedes with a slow proud motion he never goes off directly forward nor measures his paces equally but takes an oblique course going from one side to the other and bounding rather than running When the hunters approach him they either shoot or throw their javelins and in this manner disable him before he is attacked by the dogs many of whom he would otherwise destroy He is very vicious and is never killed at once but continues to fight desperately even after he has received his mortal blow He is also taken by pit falls the natives digging a deep hole in the ground and covering it slightly over with sticks

and earth, which, however, give way beneath his weight, and he sinks to the bottom, from whence he has no means of escape. But the most usual manner of taking this animal is while a cub, and incapable of resistance. The place near the den of the lioness is generally well known by the greatness of her depredations on that occasion, the natives, therefore, watch the time of her absence, and, aided by a swift horse, carry off her cubs; which they sell to strangers, or to the great men of their country."

The lion, while young and active, lives by hunting in the forest at the greatest distance from any human habitation, and seldom quits this retreat while able to subsist by his natural industry, but when he becomes old, and unfit for the purposes of surprise, he boldly comes down into places more frequented, attacks the flocks and herds that take shelter near the habitation of the shepherd or the husbandman, and depends rather upon his courage than his address for support. It is remarkable, however, that when he makes one of these desperate sallies, if he finds men and quadrupeds in the same field, he only attacks the latter, and never meddles with men, unless they provoke him to engage. It is observed that he prefers the flesh of camels to any other food. he is likewise said to be fond of that of young elephants, these he often attacks before their trunk is yet grown, and, unless the old elephant comes to their assistance, he makes them an easy prey.

The lion is terrible upon all occasions, but particularly at those seasons when he is incited by desire, or when the female has brought forth. It is then that the lioness is seen followed by eight or ten males, who fight most bloody battles among each other, till one of them becomes victorious over all the rest. She is said to bring forth in spring, and to produce but once a year. "With respect to the time of gestation, naturalists have been divided, some asserting that the lioness went with young six months, and others but two. The time also of their growth and their age have hitherto been left in obscurity, some asserting that they acquired their full growth in three years, and others that they require a longer period to come to perfection, some saying (and among this number is Mr Buffon) that they lived to but twenty, or twenty-two years at most; others making their lives even of shorter duration. All these doubts are now

reduced to certainty for we have had several of these animals bred in the Tower so that the manner of their copulation the time of their gestation the number they bring forth, and the time they take to come to perfection are all pretty well known. Although the lion emits his urine backwards yet he couples in the ordinary manner, and as was said before his internal structure in almost every respect, resembles that of a cat. The lioness however is upon these occasions particularly fierce and often wounds the lion in a terrible manner. She goes with young as I am assured by her keeper no more than five months the young ones which are never more than two in number when brought forth are about the size of a large pug dog harmless pretty and playful they continue the teat for twelve months and the animal is more than five years in coming to perfection. As to its age from its imprisoned state we can have no certainty since it is very probable that being deprived of its natural climate food and exercise its life must be very much abridged. However naturalists have hitherto been greatly mistaken as to the length of its existence. The great lion called *Pompey* which died in the year 1760 was known to have been in the Tower for above seventy years and onelately died there which was brought from the river Gambia that died above sixty three. The lion therefore is a very long lived animal and very probably in his native forests his age exceeds even that of man himself.

In this animal all the passions even of the most gentle kind are in excess but particularly the attachment of the female to her young. The lioness though naturally less strong less courageous and less mischievous than the lion becomes terrible when she has got young ones to provide for. She then makes her incursions with even more impidity than the lion himself she throws herself indiscriminately among men and other animals destroys without distinction loads herself with the spoils and brings it home reeking to her cubs whom she accustoms betimes to cruelty and slaughter. She usually brings forth in the most retired and inaccessible places and when she fears to have her retreat discovered often hides her tracks by running back her ground or by brushing them out with her tail. She sometimes also when her apprehensions are great transports them

from one place to another, and if obstructed, defends them with determined courage, and fights to the last.

The lion is chiefly an inhabitant of the torrid zone; and, as was said, is always most formidable there; nevertheless, he can subsist in more temperate climates, and there was a time when even the southern parts of Europe were infested by him. At present, he is only found in Africa and the East Indies; in some of which countries he grows to an enormous height. The lion of Bildulgeid is said to be nearly five feet high, and between nine and ten feet from the tip of the nose to the insertion of the tail. We have in the Tower, at present, one of above four feet high, that was brought from Morocco, which is the largest that, for some time past, has been seen in Europe. The ordinary size is between three and four feet; the female being, in all her dimensions, about one-third less than the male. There are no lions in America; the Puma, which has received the name of the *American lion*, is, when compared, a very contemptible animal, having neither the shape, the size, nor the mane, of the lion; being known to be extremely cowardly, to climb trees for its prey, to subsist rather by its cunning than its courage, and to be inferior even to the animal that goes by the name of the *American tiger*. We ought not, therefore, to confound this little treacherous creature with the lion, which all the ancients have concurred in denominating the *king of beasts*, and which they have described as brave and merciful. "Indeed, the numerous accounts which they have given us of this animal's generosity and tenderness, shew that there must be some foundation for the general belief of its good qualities, for mankind seldom err when they are all found to unite in the same story. However, perhaps, the caution of Aristophanes, the comic poet, is better followed in practice, who advises us to have nothing to do with this creature, but to let the lioness suckle her own whelps"*

* Ον χρη λεοντος σκυμνον εν πολει τρεφειν.

THE TIGER

THE ancients held a saying *That as the peacock is the most beautiful among birds so is the tiger among quadrupeds* * In fact no quadruped can be more beautiful than this animal the glossy smoothness of his hair, which lies much smoother and shines with greater brightness than even that of the leopard the extreme blackness of the streaks with which he is marked and the bright yellow colour of the ground which they diversify at once strike the beholder To this beauty of colouring is added an extremely elegant form much larger indeed than that of the leopard but more slender more delicate and bespeaking the most extreme swiftness and agility Unhappily however this animal's disposition is as mischievous as its form is admirable, as if Providence was willing to shew the small value of beauty by bestowing it on the most noxious of quadrupeds We have at present one of these animals in the Tower which to the view appears the most good natured and harmless creature in the world its physiognomy is far from fierce or angry it has not the commanding stern countenance of the lion but a gentle placid air yet for all this it is fierce and savage beyond measure neither correction can terrify nor indulgence can tame it

The chief and most observable distinction in the tiger and in which it differs from all others of the mottled kind is in the shape of its colours which run in streaks or bands in the same direction as his ribs from the back down to the belly The leopard the panther and the ounce are all partly covered like this animal but with this difference that their colours are broken in spots all over the body whereas in the tiger they stretch lengthwise and there is scarce a round spot to be found on his skin Besides this there are other observable distinctions the tiger is much larger and often found bigger even than the lion himself it is much slenderer also in proportion to its size its legs shorter and its neck and body longer In short of all other animals it most resembles the cat in shape and if

* Tantem autem præstat pulchritudine tigris inter alias feras quantum inter volucres pavō

we conceive the latter magnified to a very great degree, we shall have a tolerable idea of the former.

In classing carnivorous animals, we may place the lion foremost,* and immediately after him follows the tiger, which seems to partake of all the noxious qualities of the lion, without sharing any of his good ones. To pride, courage, and strength, the lion joins greatness, clemency, and generosity, but the tiger is fierce without provocation, and cruel without necessity. The lion seldom ravages except when excited by hunger; the tiger, on the contrary, though glutted with slaughter, is not satisfied, still continues the carnage, and seems to have its courage only inflamed by not finding resistance. In falling in among a flock or herd, it gives no quarter, but levels all with indiscriminate cruelty, and scarcely finds time to appease its appetite, while intent upon satisfying the malignity of its nature. It thus becomes the scourge of the country where it is found; it fears neither the threats nor the opposition of mankind, the beasts, both wild and tame, fall equally a sacrifice to its insatiable fury, the young elephant and the rhinoceros become equally its prey, and it not unfrequently ventures to attack even the lion himself.

Happily for the rest of nature, that this animal is not common, and that the species is chiefly confined to the warmest provinces of the East. The tiger is found in Malabar, in Siam, in Bengal, and in all the countries which are inhabited by the elephant or the rhinoceros. Some even pretend that it has a friendship for, and often accompanies the latter, in order to devour its excrements, which serve it as a purge. Be this as it will, there is no doubt but that they are often seen together at the sides of lakes and rivers, where they are probably both compelled to go by the thirst which, in that torrid climate, they must very often endure. It is likely enough also that they seldom make war upon each other, the rhinoceros being a peaceable animal, and the tiger knowing its strength too well to venture the engagement. It is still more likely that the tiger finds this a very convenient situation, since it can there surprise a greater number of animals, which

* The remainder of this description is taken from M^r. Buffon, except where marked with commas.

are compelled thither from the same motives. In fact it is generally known to lurk near such places where it has an opportunity of choosing its prey or rather of multiplying its massacres. When it has killed one it often goes to destroy others swallowing their blood down at large draughts and seeming rather glutted than satiated with its abundance.

However when it has killed a large animal such as a horse or a buffalo it immediately begins to devour it on the spot fearing to be disturbed. In order to feast at its ease it carries off its prey to the forest dragging it along with such ease that the swiftness of its motion seems scarcely retarded by the enormous load it sustains. From this alone we may judge of its strength but to have a more just idea of this particular let us stop a moment to consider the dimensions of this most formidable creature. Some travellers have compared it for size to a horse and others to a buffalo while others have contented themselves with saying that it is much larger than a lion. We have recent accounts of this animal's magnitude that deserve the utmost confidence. Mr Buffon has been assured by one of his friends that he saw a tiger in the East Indies fifteen feet long. Supposing that he means including the tail this animal allowing four feet for that must have been eleven feet from the tip of the nose to the insertion of the tail. Indeed that which is now in the Tower is not so large being as well as I could measure six feet from the tip to the insertion and the tail was three feet more. Like all the rest of its kind its motions are irregular and desultory it bounds rather than runs, and like them rather chooses to take its prey by surprise than to be at the trouble of hunting it down. How large a leap it can take at once we may easily judge by comparing what it might do to what we see so small an animal as the cat actually perform. The cat can leap several feet at a bound and the tiger who is ten times as long can no doubt spring proportionably.

The tiger is the only animal whose spirit seems untameable. Neither force nor constraint neither violence nor flattery can prevail in the least on its stubborn nature. The caresses of the keeper have no influence on their heart of iron and time instead of mollifying its disposition only

serves to increase its fierceness and malignity. The tiger snaps at the hand that feeds it, as well as that by which it is chastised; every object seems considered only as its proper prey, which it devours with a look, and, although confined by bars and chains, still makes fruitless efforts, as if to shew its malignity when incapable of exerting its force."

To give a still more complete idea of the strength of this terrible creature, we shall quote a passage from Father Tachard, who was an eye-witness of a combat between a tiger and three elephants at Siam. For this purpose, the king ordered a lofty pallisade to be built of bamboo cane, about a hundred feet square, and in the midst of this were three elephants appointed for combating the tiger. Their heads, and a part of their trunk, were covered with a kind of armour, like a mask, which defended that part from the assaults of the fierce animal with which they were to engage. As soon, says this author, as we were arrived at the place, a tiger was brought forth from its den, of a size much larger than we had ever seen before. It was not at first let loose, but held with cords, so that one of the elephants approaching, gave it three or four terrible blows with its trunk on the back, with such force, that the tiger was for some time stunned, and lay without motion, as if it had been dead. However, as soon as it was let loose, and at full liberty, although the first blows had greatly abated its fury, it made at the elephant with a loud shriek, and aimed at seizing his trunk. But the elephant, wrinkling it up with great dexterity, received the tiger on his great teeth, and tossed it up into the air. This so discouraged the furious animal, that it no more ventured to approach the elephant, but made several circuits round the pallisade, often attempting to fly at the spectators. Shortly after, three elephants were sent against it, and they continued to strike it so terribly with their trunks, that it once more lay for dead; and they would certainly have killed it, had not there been a stop put to the combat.

From this account, we may readily judge of the strength of this animal, which, although reduced to captivity, and held by cords, though first disabled, and set alone against three, yet ventured to continue the engagement, and even that against animals covered and protected from its fury.

' Captain Hamilton informs us that in the Sundah Rajah's dominions there are three sorts of tigers in the woods and that the smallest are the fiercest. This is not above two feet high appears to be extremely cunning and delights in human flesh. The second kind is about three feet high and hunts deer and wild hogs besides the little animal which has been already described under the name of the *cheirotain* or *Guinea deer*. The tiger of the largest sort is above three feet and a half high but although endowed with greater powers is by no means so rapacious as either of the former. This formidable animal which is called the *royal tiger* (one of which we have at present in the Tower) does not seem so ravenous nor so dangerous and is even more cowardly. A peasant in that country as this traveller informs us had a buffalo fallen into a quagmire and while he went for assistance there came a large tiger that with its single strength drew forth the animal which the united force of many men could not effect. When the people returned to the place the first object they beheld was the tiger who had thrown the buffalo over its shoulder as a fox does a goose and was carrying it away with the feet upward towards its den however as soon as it saw the men it let fall its prey and instantly fled to the woods but it had previously killed the buffalo and sucked its blood and no doubt the people were very well satisfied with its retreat. It may be observed that some East Indian buffaloes weigh above a thousand pounds which is twice as heavy as the ordinary run of our black cattle so that from hence we may form a conception of the enormous strength of this rapacious animal that could thus run off with a weight at least twice as great as that of itself.

Were this animal as common as the panther or even as the lion himself thus furnished as it is with the power to destroy and the appetite for slaughter the country would be uninhabitable where it resides. But luckily the species is extremely scarce and has been so since the earliest accounts we have had of the tiger. About the times of Augustus we are assured by Pliny * that when panthers were brought to Rome by hundreds a single tiger was considered as an extraordinary sight and he tells us

* Plin Hist Nat lib iii c 17

that the emperor Claudius was able to procure four only; which shews how difficultly they were procured. The incredible fierceness of this animal may be, in some measure, the cause of the scarcity which was then at Rome, since it was the opinion of Varro, that the tiger was never taken alive * but its being a native only of the East Indies, and that particularly of the warmer regions, it is not to be wondered that the species should be so few."

We may, therefore, consider the species of the true streaked tiger, as one of the scarcest of animals, and much less diffused than that of the lion. As to the number of its young, we have no certain accounts, however, it is said, that it brings forth four or five at a time. Although furious at all times, the female, upon this occasion, exceeds her usual rapacity; and, if her young are taken from her, she pursues the spoiler with incredible rage, he, to save a part, is contented to lose a part, and drops one of her cubs, with which she immediately returns to her den, and again pursues him, he then drops another, and by the time she has returned with that, he generally escapes with the remainder. If she loses her young entirely, she then becomes desperate, boldly approaches even the towns themselves, and commits incredible slaughter. The tiger expresses its resentment in the same manner as the lion, it moves the muscles and skin of its face, shews its teeth, and shrieks in the most frightful manner. Its note is very different from that of the lion; being rather a scream than a roar: and the ancients expressed it very well, when they said, that *tigrides indomitat rancant rugiuntque leones*.

The skin of these animals is much esteemed all over the East, particularly in China, the mandarins cover their seats of justice in the public places with it, and convert it into coverings for cushions in winter. In Europe, these skins, though but seldom to be met with, are of no great value, those of the panther and the leopard being held in much greater estimation. This is all the little benefit we derive from this dreadful animal, of which so many falsehoods have been reported, as, that its sweat was poisonous, and the hair of its whiskers more dangerous than an envenomed arrow. But the real mischiefs which the tiger occasions while living are sufficient, without giving imaginary ones to

* *Tigris vivus capi adhuc non potuit* Var de Ling Lat

the parts of its body when dead. In fact the Indians sometimes eat its flesh and find it neither disagreeable nor unwholesome.

There is an animal of America which is usually called the *red tiger* but Mr Buffon calls it the *congar* which no doubt is very different from the tiger of the East. Some however have thought proper to rank both together and I will take leave to follow their example merely because the congar is more like a tiger in every thing except the colour than any other animal I know having the head the body and the neck shap'd very much in the same manner. Of these slight differences words would give but a very faint idea it will be therefore sufficient to observe that they are both equally slender and are small & where the neck joins the head than others of the Panther kind. There is one at present in the Tower and it seemed to me as well as I could see it through the bars that were it properly stretch'd and colour'd it would in all things resemble a small tiger. It is however of a very different colour being of a deep brown and the tail very long and pointed. It is rather darker on the back under the chin it is a little whitish as also on the lower part of the belly.

Of all the American animals this is the most formidable and mischievous even their pretended lion not excepted it is said there are several sorts of them and as well as I can remember I have seen one or two here in England both differing from the present in size and conformation. It is indeed a vain endeavour to attempt to describe all the less obvious varieties in the cat kind. If we examine them minutely we shall find the differences multiply upon us so much that instead of a history we shall only be provided with a catalogue of distinctions. From such of them as I have seen within these last six years I think I could add two animals of this species that have not been hitherto described and with the names of which he that shew'd them was utterly unacquainted. But it is a poor ambition that of being eager to find out new distinctions or adding one noxious animal more to a list that is already sufficiently numerous. Were the knowing a new variety to open an unknown history or in the least to extend our knowledge the inquiry would be then worth pursuing.

but what signifies mentioning some trifling difference, and from thence becoming authors of a new name, when the difference might have originally proceeded either from climate, soil, or indiscriminate copulation ?

The cougars are extremely common in South America, and, where the towns border upon the forest, these make frequent incursions by night into the midst of the streets, carrying off fowls, dogs, and other domestic creatures. They are, however, but weak and contemptible, compared to the great tiger, being found unable to cope with a single man. The Negroes and Indians are very dexterous in encountering them, and some, even for the sake of their skins, seek them in their retreats. The arms in this combat, seemingly so dangerous, are only a lance of two or three yards long, made of heavy wood, with the point hardened in the fire, and a kind of scymetar, of about three quarters of a yard in length. Thus armed, they wait till the tiger makes an assault against the left hand, which holds the lance, and is wrapped up in a short cloak of baize. Sometimes the animal, aware of the danger, seems to decline the combat, but then its antagonist provokes it with a slight touch of the lance, in order, while he is defending himself, to strike a sure blow. As soon, therefore, as the creature feels the lance, it grasps it with one of its paws, and with the other strikes at the arm which holds it. Then it is that the person nimbly aims a blow with his scymetar, which he kept concealed, with the other hand, and hamstringing the creature, which immediately draws back enrag'd, but instantly returns to the charge. But then receiving another stroke, it is totally deprived of the power of motion, and the combatant, killing it at his leisure, strips the skin, cuts off the head, and returns to his companions, displaying these as the trophies of his victory.

This animal, as we are assured, is often more successful against the crocodile, and it is the only quadruped in that part of the world that is not afraid of the engagement. It must be no unpleasant sight to observe, from a place of safety, this extraordinary combat, between animals so terrible and obnoxious to man. Such as have seen it, describe it in the following manner. When the tiger, impelled by thirst, that seems continually to consume it, comes down

to the slight differences between this and the great panther nor have they considered its discriminations as sufficient to entitle it to another name. It has hitherto therefore gone under the name of the *PROUD* or *PANTHER* of Senegal where it is chiefly found. The differences between this animal and the former are these the large panther is often found to be six feet long from the tip of the nose to the insertion of the tail the panther of Senegal is not above four. The large panther is marked with spots in the manner of a rose that is five or six make a kind of circle and there is generally a large one in the middle. The leopard of Senegal has a much more beautiful coat the yellow is more brilliant and the spots are smaller and not disposed in rings but in clusters. As to the rest they are both whitish under the belly the tail in both is pretty long but rather longer in proportion in the latter than in the former. To these two animals whose differences seem to be so very minute we may add a third namely the *JAGUAR* or *PANTHER* of America. This in every respect resembles the two former except in the disposition of its spots and that its neck and head are rather streaked than spotted. The jaguar is also said to be lower upon its legs and less than the leopard of Senegal. These three quadrupeds as we see have but very slight differences and the principal distinction used by Mr Buffon is taken from the size the first as he says is usually six feet long the second four feet and the last about three however it appears from the particular subjects of his description that the panther in his possession was not above three feet seven inches long that the leopard's skin which he describes was about four and that the jaguar at two years old was between two and three feet long which when come to its full growth would no doubt be four feet long as well as the two former. From hence therefore we may conclude that the size in these animals is not sufficient to make a distinction among them and that those who called them all three by the indiscriminate names of the leopard and the panther if not right were at least excusable. Of those which are now to be seen in the tower the jaguar or the American panther is rather the largest of the three and is by no means the contemptible animal which Mr Buffon describes

it to be the leopard is the least of them, and has, by some travellers, been supposed to be an animal produced between the panther and the ounce, an animal which it resembles, but is less than any of the former. These three animals we may, therefore, rank together, as they agree pretty nearly in their robe, their size, their dispositions, and their ferocity.

We come next to an animal confessedly different from any of the former, being much smaller, and its colour more inclining to white. Its name, however, in our language, has caused no small confusion. It has been generally called by foreigners the ONZA, or the OUNCE, and this name some of our own writers have thought proper to give it, but others of them, and these the most celebrated, such as Willoughby, have given this name to a different animal, with a short tail, and known to the ancients and moderns by the name of the *lynx*. I confess myself at a loss, in this case, whom to follow, the alteration of names should be always made with great caution, and never but in cases of necessity. If we follow Willoughby, there will be an animal of the panther kind, very distinguishable from all the rest, left without a name, and if we recede from him, it will serve to produce some confusion among all the numerous class of readers and writers who have taken him for their guide, however, as he seems himself to have been an innovator, the name of the *lynx* having been long adopted into our language before, it was unnecessary to give the animal that bore it another name, and to call that creature an ounce, which our old writers had been accustomed to know by the Latin appellation, for this reason, therefore, we may safely venture to take a name that has been long misapplied, from the *lynx*, and restore it to the animal in question. We will, therefore, call that animal of the panther kind, which is less than the panther, and with a longer tail, the *ounce*, and the *lynx* may remain in possession of that name by which it was known among all our old English writers, as well as by all antiquity.

The OUNCE, or the ONZA of Linnæus, is much less than the panther, being not, at most, above three feet and a half long; however, its hair is much longer than that of the panther, and its tail still more so. The panther of

four or five feet long has a tail of but two feet or two feet and a half. The ounce which is but about three feet has a tail often longer than the rest of its body. The colour of the ounce is also apparently different being rather more inclining to a cream colour which is deeper on the back and whiter towards the belly. The hair on the back is an inch and a half long and that on the belly two inches and a half which is much longer than that of the panther. Its spots are disposed pretty much in the same manner as the large panther except that on the haunches it is rather marked with stripes than with spots.

Descending to animals of this kind that are still smaller we find the CATAMOUNTAIN which is the occlot of Mr Buffon or the tiger cat of most of those who exhibit it as a show. It is less than the ounce but its robe more beautifully variegated. It is an American animal and is about two feet and a half in length from the nose to the insertion of the tail. It is extremely like a cat except that it is larger and slenderer that its colours are more beautiful and its tail rather shorter. The fur is of a reddish colour the whole beautified with black spots and streaks of different figures. They are long on the back and round on the belly and paws. On the ears are black stripes which run across but in other respects they entirely resemble those of a cat. These colours however which naturalists have taken great pains minutely to describe are by no means permanent, being differently disposed in different animals of the same species. I remember to have seen an animal of this size but whether of this species I will not pretend to say some years ago that was entirely brown and was said also to have come from America.

From this tribe of the cat kind with spotted skins and a long tail we come to another with skins diversified in like manner but with a shorter tail. The principal of these is the LYNX the name by which the animal was known to Lian among the ancients and to all our old English writers among those of a more modern date. This name has been corrupted by the Portuguese into the word *ou e* and this corruption has been adopted by Ray who has improperly called this animal the *ounce* after some of the foreign travellers. The first striking distinction between

the lynx, and all those of the panther kind, is in its tail, which is at least half as short in proportion, and black at the extremity. Its fur is much longer, the spots or the skin less vivid, and but confusedly mingled with the rest. Its ears are much longer, and tipped at the points with a black tuft of hair. The colour round the eyes is white, and the physiognomy more placid and gentle. Each hair of this animal is of three different colours: the root is of a grayish brown; the middle red, or of an ash colour, and the ends white. This whiteness at the ends takes up so small a part of the particular hair, that it does not prevent us from seeing the principal colour, which is that of the middle part, so that it only makes the surface of the body appear as if it were silvered over; however, the hair of which the spots consist has no white at the ends, and at the roots it is not quite so black as the other part. This animal is not above the size of the ounce, but is rather stronger built, and it has but twenty-eight teeth; whereas all the rest of the cat kind already mentioned have thirty.

Another animal of this kind is called the *SIAGUSH*, or, as Mr Buffon names it, the *CARACAL*. It is a native of the East Indies, and resembles the lynx in size, in form, and even in the singularity of being tufted at the tips of the ears. However, the siagush differs in not being mottled as the lynx is, its fur, or rather hair, is rougher and shorter, its tail is rather longer, its muzzle more lengthened; its physiognomy more fierce, and its nature more savage.

The third and last animal that need to be mentioned of this kind, is that which Mr Buffon calls the *SERVAL*, and which he has first described. It is a native of Malabar, resembling the panther in its spots, but the lynx in the shortness of its tail, in its size, and in its strong-built form.

These seem to be all the principal distinctions among animals of the panther kind, from the largest of this tribe down to the domestic cat, which is the smallest of all these fierce and mischievous varieties. In all, their nature seems pretty much the same, being equally fierce, subtle, cruel, and cowardly. The panther, including the leopard and the jaguar, or American panther, as they are the largest, so also

are they the most dangerous of this kind for the whole race of cats are noxious in proportion to their power to do mischief. They inhabit the most torrid latitudes of India Africa and America and have never been able to multiply beyond the torrid zone. They are generally found in the thickest and the most entangled forest and often near remote habitations where they watch to surprise all kinds of domestic animals. They very seldom attack man even though provoked by him, they seem rather desirous of finding safety by flight or by climbing trees at which they are very expert. In this manner also they often pursue their prey and being expert at seizing it as well above as below they cause a vast destruction. Of all other animals these are the most sullen and even to a proverb untamable. They still preserve their fierce and treacherous spirit and at those places where they are exposed to be seen among others we often observe that while their keeper is familiar with the lion or the bear yet he is apprehensive of the large panther and keeps it bound with the shortest chain.

As the ounce differs from these in figure and size so also it seems to differ in disposition being more mild tractable and tame. These we often see as harmless and innocent as cats and there is one at present in the Tower with which the keeper plays without the smallest apprehension. I own I was not a little uneasy at first for the man when he put his hand through the bars and called the animal by its name but was a good deal surprised to see the creature which one might suppose irritated by long confinement come gently up to him stroke his hand with its face in the manner of a cat and testify the utmost gentleness of disposition. The ounce therefore is remarkable for being easily tamed and in fact it is employed all over the East for the purposes of hunting. Not indeed but that panthers themselves are sometimes used for this purpose but they are never thoroughly subdued like the former being usually brought to the field in a carriage and kept chained and caged until they are shewn the gazelle or the leveret which is their prey. Thus they pursue rather by three or four great springs than by running. If they seize it by this sudden effort it finds no mercy but if it escapes from their first effort they never attempt to pursue and

appear quite disappointed and confounded at their mischance. It sometimes happens that they are so much enraged at it, that they attack even their employer, and his only resource to avoid their fury is to throw them some small pieces of meat, which he has brought with him for that purpose.

The ounce, however, is not so dangerous; and is treated with more confidence and familiarity. It is usually brought to the field hood-winked behind one of the horsemen. When the game appears, the ounce is instantly uncovered, and shewn where it lies upon which the fierce creature darts like an arrow to the place, and seizes it at once, or, missing it, remains motionless on the place. It would be vain to attempt retrieving its disgrace, by continuing the pursuit, for, although it bounds with greater agility than most other animals, yet it is slow and awkward in running, and has no means of finding the animal it pursues by the smell, as is common among those of the dog kind. From hence, therefore, it appears, how much superior the European method of hunting is to that of the Asiatic since whatever amusement this exercise affords must arise from the continuance of the chase, and from the fluctuation of doubt and expectation, which raise and depress the pursuers by turns. All this an Asiatic hunter is deprived of, and his greatest pleasure can scarcely be more than what among us is called *coursing*, in which the dog pursues the animal, and keeps it constantly in view.

But it must not be supposed that it is from choice the Asiatics use this method of chase, for, no doubt, were dogs serviceable among them as they are in Europe, they would be employed for the same purposes. But the fact is, that the extreme heat of the tropical climates produces such universal putrefaction, and sends up such various and powerful scents, that dogs are at first bewildered in the chase, and, at last, come to lose the delicacy of their scent entirely. They are, therefore, but little used in those warm countries, and what could they avail in places where almost every other animal of the forest is stronger and more rapacious? The lion, the tiger, the panther, and the ounce, are all natural enemies to the dog, and attack him wherever he appears with ungovernable fury. The breed, therefore, in those places would quickly be destroyed, so

that they are obliged to have recourse to those animals which are more fitted to serve them, and thus convert the ounce to those purposes for which dogs are employed in Europe

The CATAMOUNTAIN or OURIOT is one of the fiercest, and for its size one of the most destructive animals in the world. It is as was before observed a native of South America and by no means capable of the same education as the ounce which it more approaches in size than in disposition. Two of these from whom Mr Buffon has taken his description were brought over from Carthagena and having been taken from the dam when very young were afterwards suckled by a bitch. But before they were three months old they had strength and ingratitude enough to kill and devour their nurse. Their succeeding fierceness and malignity seemed to correspond with their first efforts for no other arts could tame or soften their natures and while they continued in their cages they still testified an unceasing disposition for slaughter. When their food was given them the male always served himself before the female ventured to touch a bit and it was not till he was satisfied that the other began. In their savage state these animals are still more destructive having great strength and agility they very easily find and overtake their prey which they pursue among the tops of the trees as well as on the ground but what renders them still more mischievous is their unceasing appetite rather for the blood than the flesh of their prey. They suck this with the greatest avidity but frequently leave the carcase otherwise untouched in order to pursue other animals for the blood in like manner. They generally continue on the tops of trees like our wild cats where they make their nest and often bring forth their young. When they spy any animal they can master and there are but few in the forest but what are inferior they dart down upon it with inevitable exactness.

The whole tribe of animals of the panther kind with long tails are chiefly inhabitants as was said of the torrid zone but those of the short tailed kind and particularly the lynx is principally found in the cold countries that are bordering on the pole. The lynx is chiefly to be met with in the north of Germany Lathuania Muscovy Siberia,

and North America. Those of the new continent, however, are rather smaller than in Europe, as is the case with almost all their quadrupeds, they are somewhat whiter also, but in other respects there is scarcely any difference to be found among them. This animal has been called by some *lypus cerianus*, or a creature compounded between a wolf and a stag, but for what reason, is hard to guess; it no way resembles either, in shape or in disposition. In its nature, it exactly resembles the cat, except that being bigger, and nearly two feet long, it is bolder and fiercer. Like the cat, it climbs trees, and seeks its prey by surprise, like the cat, it is delicate and cleanly, covering its urine with its paws; and it resembles the wolf in nothing except its cry, which often deceives the hunters, and induces them to think they hear a wolf and not a lynx. This animal also is rather more delicate than the cat, and after having once feasted upon its prey, will never return to it again, but hunts the woods for another. From hence may have arisen the common report of the lynx having, of all other quadrupeds, the shortest memory. This, however, is not the only idle story that has been propagated of it, as of its seeing with such perspicuity, as to perceive objects through walls and mountains, as of having its urine of such a quality, as to harden and become a precious stone, with several others, propagated by ignorance or imposture.

The SYAGUSH and the SERVAL are both so like all the rest of the cat kind in disposition, that it is but repeating the same account once more to give them distinct history. As the lynx is found only in cold countries, so the syagush is to be met with only in the warm tropical climates. It is used, in the same manner as the ounce, for hunting; but it seems to have a property which the other has not; namely, that of being able to overtake its prey by pursuing it. Whether this is performed by having a finer scent than the former, or greater swiftness, we are not informed, being only told that when it overtakes either the gazelle or the antelope, it leaps upon their backs, and, getting forward to their shoulders, scratches their eyes out, by which means they become an easy prey to the hunters. Some have called this animal the *lion's provider*, and it is said, that when it calls him to pursue his prey, its voice very

* Buffon

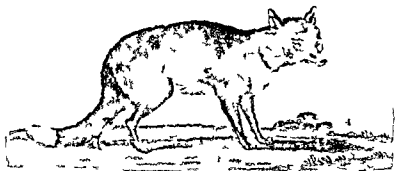
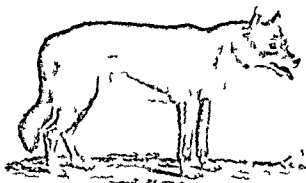
much resembles that of one man calling another * From hence we may conjecture that this animal pursues its prey in full cry and that the lion only follows to partake or seize the spoil The same account is given also of the jackal and very probably it may be true not only of these animals but of some others since it is natural enough to suppose that the lion will pursue whenever he is taught to discover his prey

We had one of these animals a few years ago sent over from the East Indies but it was not able to endure the change of climate and it died in a very short time after it was brought to the Tower Whether consumed by disease or not I cannot tell but it seemed to me much slenderer than the cat or the lynx and its ears were much longer however it is a very strong creature for its size and has been known to kill a large dog in single combat † nevertheless it is like all of the cat kind except the lion remarkable for its cowardice and will never except in cases of necessity attack an animal that is its equal in strength or activity For this reason when brought into the field and put upon a service of danger it obstinately refuses and is alert only in the pursuit of animals that are too feeble for resistance or too timid to exert their strength

From what has been said of this rapacious tribe we perceive a similitude in the manners and dispositions of them all from the lion to the cat The similitude of their internal conformation is still more exact the shortness of their intestines the number of their teeth and the structure of their paws The first of this class is the lion distinguishable from all the rest by his strength his magnitude and his mane The second is the tiger rather longer than the lion but not so tall and known by the streaks and the vivid beauty of its robe including also the American tiger or cougar distinguishable by its size next to that of the tiger its tawny colour and its spots The third is the panther and the leopard The fourth is the ounce not so large as any of the former spotted like them but distinguishable by the cream coloured ground of its hair and the great length of its tail being above the length of its body The fifth is the catamountain or tiger cat less than the ounce but differing particularly in having a shorter tail and being streaked down the back like a tiger The sixth is the short tailed kind

* Thevenot vol ii p 114

† Buffon



1 SHEPHERD'S DOG 2 BULL DOG 3 WOLF 4 FOX

namely, the lynx, of the size of the former, but with a short tail, streaked, and the tips of its ears tufted with black. The seventh is the syagush, differing from the lynx in not being mottled like it, in not being so large, and in having the ears longer, though tipped with black, as before. The eighth is the serval, resembling the lynx in its form, and the shortness of its tail, streaked also like it, but not having the tips of its ears tufted. Lastly, the cat, wild and tame, with all its varieties, all less than any of the former, but, like them, equally insidious, rapacious, and cruel.

This whole race may be considered as the most formidable enemy of mankind. there are others indeed stronger, but they are gentle, and never offer injury till injured, there are others more numerous, but they are more feeble, and rather look for safety by hiding from man, than opposing him. These are the only quadrupeds that make good their ground against him; and which may be said to keep some kingdoms of the earth in their own possession. How many extensive countries are there in Africa, where the wild beasts are so numerous, that man is deterred from living amongst them, reluctantly giving up to the lion and the leopard, extensive tracts, that seem formed only for his delight and convenience!

CHAP II

ANIMALS OF THE DOG KIND

THE second class of carnivorous quadrupeds may be denominated those of the *dog kind*. This class is neither so numerous nor so powerful as the former, and yet neither so treacherous, rapacious, or cowardly. This class may be principally distinguished by their claws, which have no sheath, like those of the cat kind, but still continue at the point of each toe, without a capability of being stretched forward, or drawn back. The nose also, as well as the jaw, of all the dog kind, is longer than in the cat, the body is, in proportion, more strongly made, and covered with hair instead of fur. There are many internal distinctions also, as in the intestines, which are much longer in the dog kind, than in those of the cat, the eye is not formed for night vision, and the olfactory nerves are dif-

fused in the dog kinds upon a very extensive membrane within the skull

If we compare the natural habitudes of this class with the former we shall find that the dog kinds are not so solitary as those of the cat but love to hunt in company and encourage each other with their mutual cries. In this manner the dog and the jackal pursue their prey and the wolf and fox which are of this kind though more solitary and silent among us yet in countries where less persecuted and where they can more fearlessly display their natural inclinations they are found to keep together in packs and pursue their game with alternate howlings

Animals of the dog kind want some of the advantages of the cat kind and yet are possessed of others in which the latter are deficient. Upon observing their claws it will easily be perceived that they cannot like cats pursue their prey up the sides of a tree and continue the chase among the branches their unmanageable claws cannot stick in the bark and thus support the body up along the trunk as we see the cat very easily perform. Whenever therefore their prey flies up a tree from them they can only follow it with their eyes or watch its motions till hunger again brings it to the ground. For this reason the proper prey of the dog kind are only those animals that like themselves are unfitted for climbing the hare the rabbit the gazelle or the roebuck

As they are in this respect inferior to the cat so they exceed it in the sense of smelling by which alone they pursue their prey with certainty of success wind it through all its mazes and tire it down by perseverance. It often happens however in the savage state that their prey is either too much diminished or too wary to serve for a sufficient supply. In this case when driven to an extremity all the dog kinds can live for some time upon fruits and vegetables which if they do not please the appetite at least serve to appease their hunger

Of all this tribe the dog has every reason to claim the preference being the most intelligent of all known quadrupeds and the acknowledged friend of mankind. The dog * independent of the beauty of his form his vivacity force and swiftness is possessed of all those internal quali-

* The rest of this description of the dog is taken from Mr. Buffon what I have added is marked as before

fications that can conciliate the affections of man, and make the tyrant a protector. A natural share of courage, an angry and ferocious disposition, renders the dog, in its savage state, a formidable enemy to all other animals. but these readily give way to very different qualities in the domestic dog, whose only ambition seems the desire to please. he is seen to come crouching along, to lay his force, his courage, and all his useful talents, at the feet of his master, he waits his orders, to which he pays implicit obedience; he consults his looks, and a single glance is sufficient to put him in motion, he is more faithful even than the most boasted among men, he is constant in his affections, friendly without interest, and grateful for the slightest favours, much more mindful of benefits received, than injuries offered, he is not driven off by unkindness, he still continues humble, submissive, and imploring, his only hope to be serviceable, his only terror to displease, he licks the hand that has been just lifted to strike him, and at last disarms resentment, by submissive perseverance.

More docile than man, more obedient than any other animal, he is not only instructed in a short time, but he also conforms to the dispositions and the manners of those who command him. He takes his tone from the house he inhabits, like the rest of the domestics, he is disdainful among the great, and churlish among clowns. Always assiduous in serving his master, and only a friend to his friends, he is indifferent to all the rest, and declares himself openly against such as seem to be dependent like himself. He knows a beggar by his clothes, by his voice, or his gestures, and forbids his approach. When at night the guard of the house is committed to his care, he seems proud of the charge, he continues a watchful sentinel, he goes his rounds, scents strangers at a distance, and gives them warning of his being upon duty. If they attempt to break in upon his territories, he becomes more fierce, flies at them, threatens, fights, and either conquers alone, or alarms those who have most interest in coming to his assistance, however, when he has conquered, he quietly reposes upon the spoil, and abstains from what he has deterred others from abusing, giving thus at once a lesson of courage, temperance, and fidelity.

From hence we see of what importance this animal is to us in a state of nature. Supposing for a moment that the species had not existed how could man without the assistance of the dog have been able to conquer time and reduce to servitude every other animal? How could he discover chase and destroy those that were noxious to him? In order to be secure and to become master of all animated nature it was necessary for him to begin by making a friend of a part of them to attach such of them to himself by kindness and cruises as seemed fittest for obedience and active pursuit. Thus the first art employed by man was in conciliating the favour of the dog and the fruits of this art were the conquest and peaceable possession of the earth.

The generality of animals have greater agility greater swiftness and more formidable arms from nature than man their senses and particularly that of smelling are far more perfect the having gained therefore a new assistant particularly one whose scent is so exquisite as that of the dog was the gaining a new sense a new faculty which before was wanting. The machines and instruments which we have imagined for perfecting the rest of the senses do not approach to that already prepared by nature by which we are enabled to find out every animal though unseen and thus destroy the noxious and use the serviceable.

The dog thus useful in himself taken into a participation of empire exerts a degree of superiority over all animals that require human protection. The flock and the herd obey his voice more readily even than that of the shepherd or the herdsman he conducts them guards them keeps them from imprudently seeking danger and their enemies he considers as his own. Nor is he less useful in the pursuit when the sound of the horn or the voice of the huntsman calls him to the field he testifies his pleasure by every little art and pursues with perseverance those animals which when taken he must not expect to divide. The desire of hunting is indeed natural to him as well as to his master since war and the chase are the only employment of savages. All animals that live upon flesh hunt by nature the lion and the tiger whose force is so great that they are sure to conquer hunt alone and without art.

the wolf, the fox, and the wild dog, hunt in packs, assist each other, and partake the spoil. But when education has perfected this talent in the domestic dog; when he has been taught by man to repress his ardour, to measure his motions, and not to exhaust his force by too sudden an exertion of it, he then hunts with method, and always with success

“ Although the wild dog, such as he was before he came under the protection of mankind, is at present utterly unknown, no such animal being now to be found in any part of the world, yet there are many that, from a domestic state, have turned savage, and entirely pursue the dictates of nature ” In those desarted and uncultivated countries where the dog is found wild, they seem entirely to partake of the disposition of the wolf; they unite in large bodies, and attack the most formidable animals of the forest, the cougar, the panther, and the bison In America, where they were originally brought by the Europeans, and abandoned by their masters, they have multiplied to such a degree, that they spread in packs over the whole country, attack all other animals, and even man himself does not pass without insult They are there treated in the same manner as all other carnivorous animals, and killed wherever they happen to come however, they are easily tamed when taken home, and treated with kindness and lenity, they quickly become submissive and familiar, and continue faithfully attached to their masters Different in this from the wolf or the fox, who, though taken never so young, are gentle only while cubs, and, as they grow older, give themselves up to their natural appetites of rapine and cruelty In short, it may be asserted, that the dog is the only animal whose fidelity is unshaken, the only one who knows his master, and the friends of the family, the only one who instantly distinguishes a stranger, the only one who knows his name, and answers to the domestic call, the only one who seems to understand the nature of subordination, and seeks assistance, the only one who, when he misses his master, testifies his loss by his complaints, the only one who, carried to a distant place, can find the way home, the only one whose natural talents are evident, and whose education is always successful

In the same manner, as the dog is of the most comply-

ing disposition so also is it the most susceptible of change in its form the varieties of this animal being too many for even the most careful describer to mention The climate the food and the education all make strong impressions upon the animal and produce alterations in its shape its colour its hair its size and in every thing but its nature The same dog taken from one climate and brought to another seems to become another animal but different breeds are as much separated to all appearance as any two animals the most distinct in nature Nothing appears to continue constant with them but their internal conformation different in the figure of the body in the length of the nose in the shape of the head in the length and the direction of the ears and tail in the colour the quality and the quantity of the hair in short, different in every thing but that make of the parts which serve to continue the species and keep the animal distinct from all others It is this peculiar conformation this power of producing an animal that can reproduce that marks the kind and approximates forms that at first sight seem never made for conjunction

From this single consideration therefore we may at once pronounce all dogs to be of one kind but which of them is the original of all the rest which of them is the savage dog from whence such a variety of descendants have come down is no easy matter to determine We may easily indeed observe that all those animals which are under the influence of man are subject to great variations Such as have been sufficiently independent so as to choose their own climate their own nourishment and to pursue their own habits preserve the original marks of nature without much deviation and it is probable that the first of these is even at this day very well represented in their descendants But such as man has subdued transported from one climate to another controlled in their manner of living and their food have most probably been changed also in their forms particularly the dog has felt these alterations more strongly than any other of the domestic kinds for living more like man he may be thus said to live more irregularly also and consequently must have felt all those changes that such variety would naturally produce Some other causes also may be assigned

for this variety in the species of the dog. as he is perpetually under the eye of his master, when accident has produced any singularity in its productions, man uses all his art to continue this peculiarity unchanged; either by breeding from such as had those singularities, or by destroying such as happened to want them, besides, as the dog produces much more frequently than some other animals, and lives a shorter time, so the chance for its varieties will be offered in greater proportion

But which is the original animal, and which the artificial or accidental variety, is a question which, as was said, is not easily resolved. If the internal structure of dogs of different sorts be compared with each other, it will be found, except in point of size, that in this respect they are exactly the same. This, therefore, affords no criterion. If other animals be compared with the dog internally, the wolf and the fox will be found to have the most perfect resemblance, it is probable, therefore, that the dog, which most resembles the wolf or the fox externally, is the original animal of its kind, for it is natural to suppose, that as the dog most nearly resembles them internally, so he may be near them in external resemblance also, except where art or accident has altered his form. This being supposed, if we look among the number of varieties to be found in the dog, we shall not find one so like the wolf or the fox as that which is called the *shepherd's dog*. This is that dog with long coarse hair on all parts except the nose, pricked ears, and a long nose, which is common enough among us, and receives his name from being principally used in guarding and attending on sheep. This seems to be the primitive animal of his kind, and we shall be the more confirmed in this opinion if we attend to the different characters which climate produces in this animal, and the different races of dogs which are propagated in every country and, in the first place, if we examine those countries which are still savage, or but half civilized, where it is most probable the dog, like his master, has received but few impressions from art, we shall find the shepherd's dog, or one very like him, still prevailing amongst them. The dogs that have run wild in America, and in Congou, approach this form. The dog of Siberia, Lapland, and Iceland, of the Cape of Good Hope, of Madagascar, Madaga, Calicut, and Malabar, have all a

long nose pricked ears and resemble the shepherd's dog very nearly. In Guinæa the dog very speedily takes this form for at the second or third generation the animal forgets to bark his ears and his tail become pointed and his hair drops off while a coarser thinner kind comes in the place. This sort of dog is also to be found in the temperate climates in great abundance particularly among those who preferring usefulness to beauty employ an animal that requires very little instruction to be serviceable. Notwithstanding this creature's deformity his melancholy and savage air he is superior to all the rest of his kind in instinct, and without any teaching naturally takes to tending flocks with an assiduity and vigilance that at once astonishes and yet relieves his master.

In more polished and civilized places the dog seems to partake of the universal refinement and like the man becomes more beautiful more majestic and more capable of assuming an education foreign to his nature. The dogs of Albany of Greece of Denmark and of Ireland are larger and stronger than those of any other kind. In Prussia Germany Spain and Italy the dogs are of various kinds like the men and this variety seems formed by crossing the breed of such as are imported from various climates.

The shepherd's dog may therefore be considered as the primitive stock from whence these varieties are all derived. He makes the stem of that genealogical tree which has been branched out into every part of the world. This animal still continues pretty nearly in its original state among the poor in temperate climates being transported into the colder regions he grows less and more ugly among the Laplanders but becomes more perfect in Iceland Russia and Siberia where the climate is less rigorous and the people more civilized. Whatever differences there may be among the dogs of these countries they are not very considerable as they all have straight ears long and thick hair a savage aspect and do not bark either so often or so loud as dogs of the more cultivated kind.

The shepherd's dog transported into the temperate climates and among people entirely civilized such as England France and Germany will be divested of his savage air his pricked ears his rough long and thick hair and from the single influence of climate and food alone will become either

a matin, a mastiff, or a hound. These three seem the immediate descendants of the former; and from them the other varieties are produced

The HOUND, the HARRIER, and the BEAGLE, seem all of the same kind, for although the bitch is covered but by one of them, yet in her litters are found puppies resembling all the three. This animal, transported into Spain or Barbary, where the hair of all quadrupeds becomes soft and long, will be there converted into the land-spaniel, and the water-spaniel, and these of different sizes

The GRAY MATIN HOUND, which is the second branch, transported to the north, becomes the great Danish dog; and this sent into the south, becomes the greyhound, of different sizes. The same transported into Ireland, the Ukraine, Tartary, Epius, and Albania, becomes the great wolf-dog, known by the name of the Irish wolf-dog.

The MASTIFF, which is the third branch, and chiefly a native of England, when transported into Denmark, becomes the little Danish dog, and this little Danish dog, sent into the tropical and warm climates, becomes the animal called the TURKISH DOG, without hair. All these races, with their varieties, are produced by the influence of climate, joined to the different food, education, and shelter, which they have received among mankind. All other kinds may be considered as mongrel races, produced by the concurrence of these, and found rather by crossing the breed than by attending to the individual. "As these are extremely numerous and very different in different countries, it would be almost endless to mention the whole; besides, nothing but experience can ascertain the reality of these conjectures, although they have so much the appearance of probability, and until that gives more certain information, we must be excused from entering more minutely into the subject

"With regard to the dogs of our country in particular, the varieties are very great, and the number every day increasing. And this must happen in a country so open by commerce to all others, and where wealth is apt to produce capricious predilection. Here the ugliest and the most useless of their kinds will be entertained merely for their singularity, and, being imported only to be looked at, they will lose even that small degree of sagacity which they possessed

in their natural climates. I omit the importation of foreign useless dogs: our own native breed is I am informed greatly degenerated and the varieties now to be found in England much more numerous than they were in the times of Queen Elizabeth when Doctor Caius attempted their natural history. Some of those he mentions are no longer to be found among us although many have since been introduced by no means so serviceable as those which have been suffered to decay.

He divides the whole race into three kinds. The first is the generous kind which consists of the terrier the harrier and the blood hound the gaze hound the grey hound the leymmer and the tumbler all these are used for hunting. Then the spaniel the setter and the water spaniel or finder were used for fowling and the spaniel gentle or lap dog for amusement. The second is the firm kind consisting of the shepherd's dog and the mastiff. And the third is the mongrel kind consisting of the wappe the turnspit and the dancier. To these varieties we may add at present the bull dog the Dutch mastiff the harlequin the pointer and the Dane with a variety of lap dogs which as they are perfectly useless may be considered as unworthy of a name.

The terrier is a small kind of hound * with rough hair made use of to force the fox or the badger out of their holes or rather to give notice by their barking in what part of their kennel the fox or badger resides when the sportsmen intend to dig them out.

The harrier as well as the beagle and the fox hound are used for hunting of all other animals they have the quickest and most distinguishing sense of smelling. The properly breeding matching and training these make up the business of many men's lives.

The blood hound was a dog of great use and in high esteem among our ancestors. Its employ was to recover any game that had crept wounded from the hunter or had been killed and stolen out of the forest. But it was still more employed in hunting thieves and robbers by their footsteps. At that time when the country was less peopled than at present and when consequently the footsteps of one man were

less crossed and obliterated by those of others, this animal was very serviceable in such pursuits, but at present, when the country is every where peopled, this variety is quite worn out, probably because it was found of less service than formerly

“The gaze-hound hunted, like our greyhounds, by the eye, and not by the scent. It chased indifferently the fox, hare, or buck. It would select from the herd the fattest and fairest deer, pursue it by the eye, and if lost recover it again with amazing sagacity. This species is now lost or unknown among us

“The greyhound is very well known at present, and was formerly held in such estimation, that it was the peculiar companion of a gentleman, who, in the times of semi-barbarism, was known by his horse, his hawk, and his greyhound. Persons under a certain rank of life are forbidden, by some late game-laws, from keeping this animal, wherefore, to disguise it the better, they cut off its tail

“The leymmer is a species now unknown to us. It hunted both by scent and sight, and was led in a leyme or thong, from whence it received its name

“The tumbler was less than the hound, more scraggy, and had pricked ears, so that by the description it seems to answer to the modern lurcher. This took its prey by mere cunning, depending neither on the goodness of its nose nor its swiftness. If it came into a warren, it neither barked nor ran on the rabbits, but, seemingly inattentive, approached sufficiently near till it came within reach, and then seized them by a sudden spring

“The land-spaniel, which probably had its name from Spain, where it might have acquired the softness of its hair, is well known at present. There are two varieties of this kind, namely, the slater, used in hawking to spring the game, and the setter, that crouches down when it scents the birds, till the net be drawn over them. I have read somewhere that the famous poet, Lord Surrey, was the first who taught dogs to set, it being an amusement to this day only known in England

“The water-spaniel was another species used in fowling. This seems to be the most docile of all the dog kind, and this docility is particularly owing to his natural attachment to man. Many other kinds will not bear correction, but

this patient creature though very fierce to strangers seems unalterable in his affections and blows and ill usage seem only to increase his regard

The lap dog at the time of Dr Caius was of Maltese breed at present it comes from different countries in general the more awkward or extraordinary these are the more they are prized

The shepherd's dog has been already mentioned and as for the mastiff he is too common to require a description Doctor Caius tells us that three of these were reckoned a match for a bear and four for a lion However we are told that three of them overcame a lion in the times of King James the First two of them being disabled in the combat, the third obliged the lion to seek for safety by flight

As to the last division namely of the wippen the turn spit and the dancier these were mongrels of no certain shape and made use of only to alarm the family or, being taught a variety of tricks were carried about as a show

With regard to those of later importation the bull dog as Mr Buffon supposes is a breed between the small Dane and the English mastiff The large Dane is the tallest dog that is generally bred in England It is somewhat between a mastiff and a greyhound in shape being more slender than the one and much stronger than the other They are chiefly used rather for show than service being neither good in the yard nor the field The highest are most esteemed and they generally cut off their ears to improve their figure as some absurdly suppose The harlequin is not much unlike the small Dane being an useless animal somewhat between an Italian greyhound and a Dutch mastiff To these several others might be added such as the pug dog the black breed and the pointer but in fact, the varieties are so numerous as to fatigue even the most ardent curiosity *

Of these of the foreign kinds I shall mention only three

* To these may be added the Newfoundland dog so remarkable for its sagacity and faithful attachment to its master and the Siberian dog so well known in Kamtschka for drawing sledges over the ice The former of the two is a large handsome animal with a remarkably benevolent and pleasing countenance They are web footed and can swim with great ease and swiftness

which are more remarkable than any of the rest. The lion-dog greatly resembles that animal, in miniature, from whence it takes the name. The hair of the fore part of the body is extremely long, while that of the hinder part is as short. The nose is short, the tail long, and tufted at the point, so that, in all these particulars, it is entirely like the lion. However, it differs very much from that fierce animal in nature and disposition, being one of the smallest animals of its kind, extremely feeble, timid, and inactive. It comes originally from Malta, where it is found so small that women carry it about in their sleeves.

That animal, falsely called the *Turkish dog*, differs greatly from all the rest of the kind, in being entirely without hair. The skin, which is perfectly bare, is of a flesh colour, with brown spots, and their figure, at first view, is rather disgusting. These seem to be of the small Danish breed, brought into a warm climate, and there, by a succession of generations, divested of their hair. For this reason, they are extremely chilly, and unable to endure the cold of our climate, and even in the midst of summer they continue to shiver as we see men in a frosty day. Their spots are brown, as was said, well-marked, and easily distinguishable in summer, but in the cold of winter they entirely disappear. They are called the Turkish breed, although brought from a much warmer climate, for some of them have been known to come from the warmest parts of Africa and the East Indies.

“The last variety, and the most wonderful of all that I shall mention, is the great Irish wolf-dog, that may be considered as the first of the canine species. This animal, which is very rare, even in the only country in the world where it is to be found, is rather kept for show than use, there being neither wolves nor any other formidable beasts of prey in Ireland, that seem to require so powerful an antagonist. The wolf-dog is therefore bred up in the houses of the great, or such gentlemen as choose to keep him as a curiosity, being neither good for hunting the hare, the fox, nor the stag, and equally unserviceable as a house-dog. Nevertheless, he is extremely beautiful and majestic to appearance, being the greatest of the dog kind to be seen in the world. The largest of those I have seen, and I have seen above a dozen, was about four feet high, or as tall as a

calf of a year old. He was made extremely like a greyhound, but rather more robust and inclining to the figure of the French mastiff or the great Dane. His eye was mild his colour white and his nature seemed heavy and phlegmatic. This I ascribed to his having been bred up to a size beyond his nature, for we see in man and all other animals that such as are overgrown are neither so vigorous nor alert as those of more moderate stature. The greatest pains have been taken with these to enlarge the breed both by food and matching. This end was effectually obtained indeed for the size was enormous but as it seemed to me at the expense of the animal's fierceness vigilance and sagacity. — However I was informed otherwise the gentleman who bred them assuring me that a mastiff would be nothing when opposed to one of them who generally seized their antagonist by the back he added that they would worry the strongest bull dogs in a few minutes to death. But this strength did not appear either in their figure or their inclinations they seemed rather more timid than the ordinary race of dogs and their skin was much thinner and consequently less fitted for combat. Whether with these disadvantages they were capable as I was told of singly coping with bears others may determine however they have but few opportunities in their own country of exerting their strength as all wild carnivorous animals there are only of the vermin kind. Mr Buffon seems to be of opinion that these are the true Molossian dogs of the ancients he gives no reason for this opinion and I am apt to think it ill grounded. Not to trouble the reader with a tedious critical disquisition which I have all along avoided it will be sufficient to observe that Nemesianus in giving directions for the choice of a bitch advises to have one of Spartan or Molossian breed and among several other perfections he says that the ears should be dependent and fluctuate as she runs *. This however is by no means the case with the Irish wolf dog whose ears resemble those of the greyhound and are far from fluctuating with the animal's

* *Elige tunc cursu sic lem facilemque re ursu
In Lacedæmonio natam seu rure Molosso—
Rex bus amplius satis validus ducit que coxas
Cuique nimis molles fluctent in cursibus aures*

motions But, of whatever kinds these dogs may be, whether known among the ancients, or whether produced by a later mixture, they are now almost quite worn away, and are very rarely to be met with even in Ireland If carried to other countries, they soon degenerate, and even at home, unless great care be taken, they quickly alter. They were once employed in clearing the island of wolves, which infested it in great plenty, but these being destroyed, the dogs also are wearing away, as if Nature meant to blot out the species, when they had no longer any services to perform

“ In this manner several kinds of animals fade from the face of Nature, that were once well known, but are now seen no longer The enormous elk of the same kingdom, that, by its horns, could not have been less than eleven feet high, the wolf, and even the wolf dog, are extinct, or only continued in such a manner as to prove their former plenty and existence From hence, it is probable, that many of the nobler kinds of dogs, of which the ancients have given us such beautiful descriptions, are now utterly unknown; since among the whole breed we have not one that will venture to engage the lion or the tiger in single combat The English bull-dog is perhaps the bravest of the kind; but what are his most boasted exploits to those mentioned of the Epirotic dogs by Pliny, or the Indian dogs by Ælian? The latter gives us a description of a combat between a dog and a lion, which I will take leave to translate.

“ When Alexander was pursuing his conquests in India, one of the principal men of that country was desirous of shewing him the value of the dogs which his country produced Bringing his dog into the king's presence, he ordered a stag to be let loose before him, which the dog, despising as an unworthy enemy, remained quite regardless of the animal, and never once stirred from his place His master then ordered a wild boar to be set out, but the dog thought even this a despicable foe, and remained calm and regardless as before He was next tried with a bear, but still despising his enemy, he only waited for an object more worthy of his courage and his force At last they brought forth a tremendous lion, and then the dog acknowledged his antagonist, and prepared for combat He instantly discovered a degree of ungovernable ardour; and, flying at

the lion with fury seized him by the throat and totally disabled him from resistance. Upon this the Indian who was desirous of surprising the king and knowing the constancy and bravery of his dog ordered his tail to be cut off which was easily performed as the bold animal was employed in holding the lion. He next ordered one of his legs to be broken which however did not in the least abate the dog's ardour but he still kept his hold as before. Another leg was then broken but the dog as if he had suffered no pain only pressed the lion still the more. In this cruel manner all his legs were cut off without abating his courage and at last when even his head was separated from his body the jaws seemed to keep their former hold. A sight so cruel did not fail to affect the king with very strong emotions at once pitying the dog's fate and admiring his fortitude. Upon which the Indian seeing him thus moved presented him with four dogs of the same kind, which in some measure alleviated his uneasiness for the loss of the former.

The breed of dogs however in that country is at present very much inferior to what this story seems to imply since in many places instead of dogs they have animals of the cat kind for hunting. In other places also this admirable and faithful animal instead of being applied to his natural uses is only kept to be eaten. All over China there are dog butchers and shambles appointed for selling their flesh. In Canton particularly there is a street appointed for that purpose and what is very extraordinary wherever a dog butcher appears all the dogs of the place are sure to be in full cry after him they know their enemy and persecute him as far as they are able. Along the coasts of Guinea their flesh is esteemed a delicacy by the Negroes and they will give one of their cows for a dog. But among this barbarous and brutal people scarce any thing that has life comes amiss and they may well take up with a dog since they consider toads lizards and even the flesh of the tiger itself as a dainty. It may perhaps happen that the flesh of this animal which is so indifferent in the temperate climates may assume a better quality in those which are more warm but it is more than probable that the diversity is rather in man than in the flesh of the dog since in the cold countries the flesh is eaten with equal appetite by the

savages, and they have then dog-feasts in the same manner as we have ours for venison

In our climate, the wild animals that most approach the dog are the wolf and the fox, these, in their internal conformation, greatly resemble each other, and yet in their natures are very distinct. The ancients asserted that they bred together, and I am assured, by credible persons, that there are many animals in this country bred between a dog and a fox. However, all the endeavours of Mr Buffon to make them engender, as he assures us, were ineffectual. For this purpose, he bred up a young wolf, taken in the woods, at two months old, with a matin dog of the same age. They were shut up together, without any other, in a large yard, where they had a shelter for retiring. They neither of them knew any other individual of their kind, nor even any other man, but he who had the charge of feeding them. In this manner they were kept for three years, still with the same attention, and without constraining or tying them up. During the first year the young animals played with each other continually, and seemed to love each other very much. In the second year, they began to dispute about their victuals, although they were given more than they could use. The quarrel always began on the wolf's side. They were brought their food, which consisted of flesh and bones, upon a large wooden platter, which was laid on the ground. Just as it was put down, the wolf, instead of falling to the meat, began by diving off the dog, and took the platter in its teeth so expertly, that it let nothing of what it contained fall upon the ground, and in this manner carried it off, but as the wolf could not entirely escape, it was frequently seen to run with the platter round the yard five or six times, still carrying it in a position that none of its contents could fall. In this manner it would continue running, only now and then stopping to take breath, until the dog coming up, the wolf would leave the victuals to attack him. The dog, however, was the stronger of the two, but as it was more gentle, in order to secure him from the wolf's attack, he had a collar put round his neck. In the third year, the quarrels of these ill-paired associates were more vehement, and their combats more frequent, the wolf, therefore, had a collar put about its neck, as well as the dog, who began to be more fierce and unmerciful. During the two first years, neither

seemed to testify the least tendency towards engendering and it was not till the end of the third that the wolf which was the female shewed the natural desire but without abating either in its fierceness or obstinacy. This appetite rather increased than repressed their mutual animosity they became every day more untractable and ferocious and nothing was heard between them but the sounds of rage and resentment. They both in less than three weeks became remarkably lean without ever approaching each other but to combat. At length their quarrels became so desperate that the dog killed the wolf who was become more weak and feeble and he was soon after himself obliged to be killed for upon being set at liberty he instantly flew upon every animal he met fowls dogs and even men themselves not escaping his savage fury.

The same experiment was tried upon foxes taken young but with no better success they were never found to engender with dogs and our learned naturalist seems to be of opinion that their natures are too opposite ever to provoke natural desire. One thing however must be remarked that the animals on which he tried his experiments were rather too old when taken and had partly acquired their natural savage appetites before they came into his possession. The wolf as he acknowledges was two or three months old before it was caught and the foxes were taken in traps. It may therefore be easily supposed that nothing could ever after thoroughly tame those creatures that had been suckled in the wild state and had caught all the habits of the dam. I have seen these animals when taken earlier in the woods become very tame and indeed they rather were displeasing by being too familiar than too shy. It were to be wished that the experiment were tried upon such as these and it is more than probable that it would produce the desired success. Nevertheless these experiments are sufficient to prove that neither the wolf nor the fox are of the same nature with the dog but each of a species perfectly distinct and their joint produce most probably unfruitful.

The dog when first whelped is not a completely finished animal. In this kind as in all the rest which bring forth many at a time the young are not so perfect as in those which bring forth but one or two. They are always produced with the eyes closed the lids being held together

not by sticking, but by a kind of thin membrane, which is torn as soon as the upper eye-lid becomes strong enough to raise it from the under. In general, their eyes are not opened till ten or twelve days old. During that time, the bones of the skull are not completed, the body is puffed up, the nose is short, and the whole form but ill sketched out. In less than a month the puppy begins to use all its senses, and from thence makes hasty advances to its perfection. At the fourth month, the dog loses some of his teeth, as in other animals, and these are renewed by such as never fall. The number of these amount to forty-two, which is twelve more than is found in any of the cat kind, which are known never to have above thirty. The teeth of the dog being his great and only weapon, are formed in a manner much more serviceable than those of the former; and there is scarce any quadruped that has a greater facility in rending, cutting, or chewing its food. He cuts with his incisors or fore-teeth, he holds with his four great canine teeth, and he chews his meat with his grinders; these are fourteen in number, and so placed, that, when the jaws are shut, there remains a distance between them, so that the dog, by opening his mouth ever so wide, does not lose the power of his jaws. But it is otherwise in the cat kind, whose incisors, or cutting-teeth, are very small, and whose grinding teeth, when brought together, touch more closely than those of the dog, and, consequently, have less power. Thus, for instance, I can squeeze any thing more forcibly between my thumb and fore-finger, where the distance is greater, than between any other two fingers, whose distance from each other is less.

This animal is capable of reproducing at the age of twelve months,* goes nine weeks with young, and lives to about the age of twelve years. Few quadrupeds are less delicate in their food, and yet there are many kinds of birds which the dog will not venture to touch. He is even known, although in a savage state, to abstain from injuring some, which one might suppose he had every reason to oppose.

* To this description I will beg leave to add a few particulars from Linnæus, as I find them in the original. "*Vomitua gramina purgatur, cacat supra lapidem. Album græcum antisepticum summum. Mingit ad latus* (this, however, not till the animal is nine months old) *cum hospite sæpe centies. Odoat anum alterius. Prociis rivantibus crudelis. Menstruans corit cum variis. Mordet illa illos. Cohæret copula junctus*."

The dogs and the vultures which live wild about Grand Cairo in Egypt (for the Mahometan law has expelled this useful animal from human society) continue together in a very sociable and friendly manner *. As they are both useful in devouring such carcases as might otherwise putrefy and thus infect the air the inhabitants supply them with provisions every day in order to keep them near the city. Upon these occasions the quadrupeds and birds are often seen together tearing the same piece of flesh without the least enmity on the contrary they are known to live together with a kind of affection and bring up their young in the same nest.

Although the dog is a voracious animal yet he can bear hunger for a very long time. We have an instance in the Memoirs of the Academy of Sciences of this kind in which a bitch that had been forgotten in a country house lived forty days without any other nourishment than the wool of a quilt which she had torn in pieces. It should seem that water is more necessary to the dog than food he drinks often though not abundantly and it is commonly believed that when abridged in water he runs mad. This dreadful malady the consequences of which are so well known is the greatest inconvenience that results from the keeping this faithful domestic. But it is a disorder by no means so frequent as the terrors of the timorous would suppose the dog has been often accused of madness without a fair trial and some persons have been supposed to receive their deaths from his bite when either their own ill grounded fears or their natural disorders were the true cause †

THE WOLF

THE dog and the wolf are so very much alike internally that the most expert anatomists can scarcely perceive the difference and it may be asserted also that externally some dogs more nearly resemble the wolf than they do each other. It was this strong similitude that first led some

* Hist. Just. Iter. Iale. tin. p. 230

† The following curious circumstance is attested by the celebrated Leibnitz. A little boy the son of a peasant of Saxony fancying he could in his long voice announce in a distinct manner of certain words took it into his head to teach him to speak. The dog was then about three years old and as at length made to articulate no less than thirty words calling distinctly for tea coffee chocolate &c. It was necessary however that the words should be first pronounced to him each time which he says were echoed to his preceptor.

naturalists to consider them as the same animal, and to look upon the wolf as the dog in its state of savage freedom however, this opinion is entertained no longer, the natural antipathy those two animals bear to each other, the longer time which the wolf goes with young than the dog, the one going over a hundred days, and the other not quite sixty, the longer period of life in the former than the latter, the wolf living twenty years, the dog not fifteen, all sufficiently point out a distinction, and draw a line that must for ever keep them asunder

The wolf, from the tip of the nose to the insertion of the tail, is about three feet seven inches long, and about two feet five inches high, which shews him to be larger than our great breed of mastiffs, which are seldom found to be above three feet by two His colour is a mixture of black, brown, and gray, extremely rough and hard, but mixed towards the roots with a kind of ash-coloured fur In comparing him to any of our well-known breed of dogs, the great Dane or mongrel greyhound, for instance, he will appear to have the legs shorter, the head larger, the muzzle thicker, the eyes smaller, and more separated from each other, and the ears shorter and straighter He appears in every respect stronger than the dog, and the length of his hair contributes still more to his robust appearance. The feature which principally distinguishes the visage of the wolf from that of the dog is the eye, which opens slantingly upwards in the same direction with the nose, whereas, in the dog, it opens more at right angles with the nose, as in man The tail, also, in this animal, is long and bushy; and he carries it rather more between his hind legs than the dog is seen to do The colour of the eye-balls in the wolf are of a fiery green, and gives his visage a fierce and formidable air, which his natural disposition does by no means contradict *

The wolf is one of those animals whose appetite for animal food is the most vehement, and whose means of satisfying this appetite are the most various Nature has furnished him with strength, cunning, agility, and all those requisites which fit an animal for pursuing, overtaking,

* The rest of this history of the wolf is taken from Mr Buffon; and I look upon it as a complete model for natural history If I add or differ, I mark it as usual

and conquering its prey, and yet with all these the wolf most frequently dies of hunger for he is the declared enemy of man. Being long proscribed and a reward offered for his head he is obliged to fly from human habitations and to live in the forest where the few wild animals to be found there escape him either by their swiftness or their art or are supplied in too small a proportion to satisfy his rapacity. He is naturally dull and cowardly but frequently disappointed and as often reduced to the verge of famine he becomes ingenious from want and courageous from necessity. When pressed with hunger he braves danger and comes to attack those animals which are under the protection of man particularly such as he can readily carry away lambs sheep or even dogs themselves for all animal food becomes then equally agreeable. When this excursion has succeeded he often returns to the charge until having been wounded or hard pressed by the dogs or the shepherds he hides himself by day in the thickest coverts and only ventures out at night. He then sallies forth over the country keeps peering round the villages carries off such animals as are not under protection attacks the sheepfolds scratches up and undermines the thresholds of doors where they are housed enters furiously and destroys all before he begins to fix upon and carry off his prey. When these sallies do not succeed he then returns to the thickest part of the forest content to pursue those smaller animals which even when taken afford him but a scanty supply. He there goes regularly to work follows by the scent opens to the view still keeps following hopeless himself of overtaking the prey but expecting that some other wolf will come in to his assistance and then content to share the spoil. At last when his necessities are very urgent he boldly faces certain destruction he attacks women and children and sometimes ventures even to fall upon men becomes furious by his continual agitations and ends his life in madness.

The wolf as well externally as internally so nearly resembles the dog that he seems modelled upon the same plan and yet he only offers the reverse of the medal. If his form be like his nature is so different that he only preserves the ill qualities of the dog without any of his good ones. Indeed they are so different in their disposi-

tions, that no two animals can have a more perfect antipathy to each other. A young dog shudders at the sight of a wolf, he even shuns his scent, which, though unknown, is so repugnant to his nature, that he comes trembling to take protection near his master. A dog who is stronger, and who knows his strength, hustles up at the sight, testifies his animosity, attacks him with courage, endeavours to put him to flight, and does all in his power to rid himself of a presence that is hateful to him. They never meet without either flying or fighting, fighting for life and death, and without mercy on either side. If the wolf is the stronger, he tears and devours his prey; the dog, on the contrary, is more generous, and contents himself with his victory, he does not seem to think that *the body of a dead enemy smells well*, he leaves him where he falls, to serve as food for birds of prey, or for other wolves, since they devour each other, and when one wolf happens to be desperately wounded, the rest track him by his blood, and are sure to shew him no mercy.

The dog, even in his savage state, is not cruel, he is easily tamed, and continues firmly attached to his master. The wolf, when taken young, becomes tame, but never has an attachment. Nature is stronger in him than education, he resumes with age his natural dispositions, and returns as soon as he can to the woods from whence he was taken. Dogs, even of the dullest kinds, seek the company of other animals; they are naturally disposed to follow and accompany other creatures besides themselves; and even by instinct, without any education, take to the care of flocks and herds. The wolf, on the contrary, is the enemy of all society, he does not even keep much company with those of his kind. When they are seen in packs together, it is not to be considered as a peaceful society, but a combination for war; they testify their hostile intentions by their loud howlings, and, by their fierceness, discover a project for attacking some great animal, such as a stag or a bull, or to destroy some more redoubtable watch-dog. The instant their military expedition is completed, their society is at an end, they then part, and each returns in silence to his solitary retreat. There is not even any strong attachments between the male and female, they seek each other only once a year, and remain

but a few days together they always couple in winter at which time several males are seen following one female and this association is still more bloody than the former they dispute most cruelly growl bark fight and tear each other and it sometimes happens that the majority kill the wolf which has been chiefly preferred by the female. It is usual for the she wolf to fly from them all with him she has chosen, and watches this opportunity when the rest are asleep.

The season for coupling does not continue above twelve or fifteen days and usually commences among the oldest those which are young being later in their desires. The males have no fixed time for engendering they pass from one female to the other beginning at the end of December and ending at the latter end of February. The time of pregnancy is about three months and a half and the young wolves are found from the latter end of April to the beginning of July. The long continuance of the wolf's pregnancy is sufficient to make a distinction between it and the dog did not also the fiery fierceness of the eyes the howl instead of barking and the greater duration of its life leave no doubt of its being an animal of its own particular species. In other respects however they are entirely alike the wolf couples exactly like the dog the parts are formed in the same manner and their separation hindered by the same cause. When the she wolves are near their time of bringing forth they seek some very tufted spot in the thickest part of the forest in the middle of this they make a small opening cutting away the thorns and briars with their teeth and afterwards carry thither a great quantity of moss which they form into a bed for their young ones. They generally bring forth five or six and sometimes even to nine at a litter. The cubs are brought forth like those of the bitch with the eyes closed the dam suckles them for some weeks and teaches them betimes to eat flesh which she prepares for them by chewing it first herself. Some time after she brings them stronger food hares partridges and birds yet alive. The young wolves begin by playing with them and end by killing them. The dam then strips them of their feathers tears them in pieces and gives to each of them a share. They do not leave the den where they

have been littered, till they are six weeks or two months old. They then follow the old one, who leads them to drink to the trunk of some old tree, where the water has settled, or at some pool in the neighbourhood. If she apprehends any danger, she instantly conceals them in the first convenient place, or brings them back to their former retreat. In this manner they follow her for some months: when they are attacked, she defends them with all her strength, and more than usual ferocity. Although, at other times, more timorous than the male, at that season she becomes bold and fearless; willing perhaps to teach the young ones future courage by her own example. It is not till they are about ten or twelve months old, and until they have shed their first teeth, and completed the new, that she thinks them in a capacity to shift for themselves. Then, when they have acquired arms from Nature, and have learned industry and courage from her example, she declines all future care of them, being again engaged in bringing up a new progeny.

The males and females are in a capacity to engender when two years old. It is probable that the females of this species, as well as of most others, are sooner completed than the males, but this is certain, that they never desire to copulate until their second winter. From whence we may suppose that they live fifteen or twenty years, for allowing three years for their complete growth, this multiplied by seven, gives them a life of twenty-one, most animals, as has been observed, living about seven times the number of years which they take to come to perfection. Of this, however, there is as yet no certainty, no more than of what huntsmen assert, that in all the litters there are more males than females. From them also we learn, that there are some of the males who attach themselves to the female, who accompany her during her gestation, until the time of bringing forth, when she hides the place of her retreat from the male, lest he should devour her cubs. But after this, when they are brought forth, that he then takes the same care of them as the female, carries them provisions, and, if the dam should happen to be killed, rears them up in her stead.

The wolf grows gray as he grows old, and his teeth wear, like those of most other animals, by using. He

sleeps when his belly is full or when he is fatigued rather by day than night and always like the dog is very easily waked. He drinks frequently and in times of drought when there is no water to be found in the trunks of old trees or in the pools about the forest he comes often in the day down to the brooks or the lakes in the plain. Although very voracious he supports hunger for a long time and often lives four or five days without food provided he be supplied with water.

The wolf has great strength particularly in his fore parts in the muscles of his neck and jaws. He carries off a sheep in his mouth without letting it touch the ground and runs with it much swifter than the shepherds who pursue him so that nothing but the dogs can overtake and oblige him to quit his prey. He bites cruelly and always with greater vehemence in proportion as he is least resisted for he uses precautions with such animals as attempt to stand upon the defensive. He is ever cowardly and never fights but when under a necessity of satisfying hunger or making good his retreat. When he is wounded by a bullet he is heard to cry out and yet when surrounded by the peasants and attacked with clubs he never howls as a dog under correction but defends himself in silence and dies as hard as he lived.

His nature is in fact more savage than that of the dog he has less sensibility and greater strength. He travels runs and keeps plundering for whole days and nights together. He is in a manner indefatigable and perhaps of all animals he is the most difficult to be hunted down. The dog is good natured and courageous the wolf though savage is ever fearful. If he happens to be caught in a pit fall he is for some time so frightened and astonished that he may be killed without offering to resist or taken alive without much danger. At that instant one may clap a collar round his neck muzzle him and drag him along without his ever giving the least signs of anger or resentment. At all other times he has his senses in great perfection his eye his ear and particularly his sense of smelling which is even superior to the two former. He smells a carcase at more than a leagues distance he also perceives living animals a great way off and follows them a long time upon the scent. Whenever he leaves the

wood, he always takes care to go out against the wind. When just come to its extremity, he stops to examine, by his smell, on all sides, the emanations that may come either from his enemy or his prey, which he very nicely distinguishes. He prefers those animals which he kills himself to those he finds dead, and yet he does not disdain these when no better is to be had. He is particularly fond of human flesh, and perhaps, if he were sufficiently powerful, he would eat no other. Wolves have been seen following armies, and arriving in numbers upon the field of battle, where they devoured such dead bodies as were left upon the field, or but negligently interred. These, when once accustomed to human flesh, ever after seek particularly to attack mankind, and choose to fall upon the shepherd rather than his flock. We have had a late instance of two or three of these keeping a whole province, for more than a month, in a continual alarm.

It sometimes happens that a whole country is called out to extirpate these most dangerous invaders. The hunting the wolf is a favourite diversion among the great of some countries, and it must be confessed it seems to be the most useful of any. These animals are distinguished by the huntsman into the *young wolf*, the *old wolf*, and the *great wolf*. They are known by the prints of their feet, the older the wolf, the larger the track he leaves. That of the female is narrower and longer than that of the male. It is necessary to have a very good starter to put up the wolf, and it is even convenient to use every art to encourage him in his pursuit, for all dogs have a natural repugnance against this animal, and are but cold in their endeavours. When the wolf is once put up, it is then proper to have greyhounds to let fly at him, in leashes, one after the other. The first leash is sent after him in the beginning, seconded by a man on horseback, the second are let loose about half a mile farther, and the third when the rest of the dogs come up with and begin to bait him. He for a long time keeps them off, stands his ground, threatens them on all sides, and often gets away, but usually the hunters arriving, come in aid of the dogs, and help to dispatch him with their cutlasses. When the animal is killed, the dogs testify no appetite to enjoy their victory, but leave

him where he falls a frightful spectacle and even in death hideous

The wolf is sometimes also hunted with harrers but as he always goes straight forward and often holds his speed for a whole day together this kind of chase is tedious and disagreeable at least if the harrers are not assisted by greyhounds who may harry him at every view Several other arts have also been used to take and destroy this noxious animal He is surrounded and wounded by men and large house dogs he is secured in traps he is poisoned by carcasses prepared and placed for that purpose, and is caught in pit falls Gesner tells us of a friar a woman and a wolf being taken in one of these all in the same night The woman lost her senses by the fright the friar his reputation and the wolf his life All these disasters however do not prevent this animal multiplying in great numbers particularly in countries where the woods are plenty France Spain and Italy are greatly infested with them but England Ireland and Scotland are happily set free

King Edgar is said to be the first who attempted to rid this kingdom of such disagreeable inmates by commuting the punishment for certain crimes into the acceptance of a number of wolves tongues from each criminal * However some centuries after these animals were again increased to such a degree as to become the object of royal attention accordingly Edward the First issued out his mandate to one Peter Corbet to superintend and assist in the destruction of them They are said to have infested Ireland long after they were extirpated in England however the oldest men in that country remember nothing of these animals and it is probable that there have been none there for more than a century past Scotland also is totally free

The colour of this animal differs according to the different climates where it is bred and often changes even in the same country Besides the common wolves which are found in France and Germany there are others with thicker hair inclining to yellow These are more savage and less noxious than the former neither approaching the flocks nor habitations and living rather by the chase than

* British Zoology p 67

rapine In the northern climates there are found some quite black, and some white all over The former are larger and stronger than those of any other kinds

The species is very much diffused in every part of the world, being found in Asia, Africa, and in America, as well as Europe The wolves of Senegal resemble those of France, except that they are larger and much fiercer than those of Europe Those of Egypt are smaller than those of Greece In the East, the wolf is trained up for a show, being taught to dance and play tricks, and one of these thus educated often sells for four or five hundred crowns “It is said that in Lapland the wolf will never attack a rein-deer that is seen haltered, for this wary animal, being well acquainted with the nature of a trap, suspects one wherever it perceives a rope However, when he sees the deer entirely at liberty, he seldom fails to destroy it

“The wolf of North America is blacker and much less than those in other parts of the world, and approaches nearer in form to the dog than those of the ordinary kind * In fact, they were made use of as such by the savages, till the Europeans introduced others, and even now, on the remoter shores, or the more inland parts of the country, the savages still make use of these animals in hunting They are very tame and gentle, and those of this kind that are wild, are neither so large nor so fierce as an European wolf, nor do they ever attack mankind They go together in large packs by night to hunt the deer, which they do as well as any dogs in England, and it is confidently asserted that ‘one of them is sufficient to run down a deer † Whenever they are seen along the banks of those rivers near which the wandering natives pitch their huts, it is taken for granted that the bison or the deer are not far off and the savages affirm that the wolves come with the tidings, in order to have the garbage, after the animal has been killed by the hunters Catesby adds a circumstance relative to these animals, which, if true, invalidates many of Mr Buffon’s observations in the foregoing history He asserts, that these being the only dogs used by the Americans, before the arrival of the Europeans among them, they have since engendered together, and

* Brookes’s Natural History, vol 1 p 198

† Dictionnaire Raisonné, Loup

that their breed may become prolific which proves the dog and the wolf to be of the same species. It were to be wished that this fact were better ascertained, we should then know to a certainty in what degree the dog and wolf resemble each other as well in nature as in conformation. we might then perhaps be enabled to improve the breed of our dogs by bringing them back to their native forms and instincts. we might by crossing the strain restore that race of those bold animals which the ancients assure us were more than a match for the lion.

However this animal may be useful in North America the wolf of Europe is a very noxious animal and scarcely any thing belonging to him is good except his skin. Of this the furriers make a covering that is warm and durable though coarse and unsightly. His flesh is very indigestible and seems to be disliked by all other animals no other creature being known to eat the wolf's flesh except the wolf himself. He breathes a most fetid vapour from his jaws as his food is indiscriminate often putrid and seldom cleanly. In short every way offensive a savage aspect a frightful howl an insupportable odour a perverse disposition fierce habits he is hateful while living and useless when dead.*

THE FOX

THE fox very exactly resembles the wolf and the dog internally and although he differs greatly from both in size and carriage yet when we come to examine his stripes minutely there will appear to be very little difference in the description. Were for instance a painter to draw from a natural historian's exactest description the figure of a dog a wolf and a fox without having ever seen either he would be very apt to confound all these animals together or rather he would be unable to catch those peculiar outlines that no description can supply.

* The wolf is sometimes affected with madness in symptoms and consequences exactly similar to that which affects the dog. This disease as it happens to them in the depth of winter cannot be attributed to

Words will never give any person an exact idea of forms any way irregular, for although they be extremely just and precise, yet the numberless discriminations to be attended to will confound each other, and we shall no more conceive the precise form, than we should be able to tell when one pebble more was added or taken away from a thousand. To conceive, therefore, how the fox differs in form from the wolf or the dog, it is necessary to see all three, or at least to supply the defects of description by examining the difference in a print.

The fox is of a slenderer make than the wolf, and not near so large; for as the former is above three feet and a half long, so the other is not above two feet three inches. The tail of the fox also is longer in proportion, and more bushy; its nose is smaller, and approaching more nearly to that of the greyhound, and its hair softer. On the other hand, it differs from the dog in having its eyes obliquely situated, like those of the wolf, its ears are directed also in the same manner as those of the wolf, and its head is equally large in proportion to its size. It differs still more from the dog in its strong offensive smell, which is peculiar to the species, and often the cause of their death. However, some are ignorantly of opinion that it will keep off infectious diseases, and they preserve this animal near their habitations for that very purpose.

The fox has since the beginning been famous for his cunning and his arts, and he partly merits his reputation. Without attempting to oppose either the dogs or the shepherds, without attacking the flock, or alarming the village, he finds an easier way to subsist, and gains by his address what is denied to his strength or courage. Patient and prudent, he waits the opportunity for depredation, and varies his conduct with every occasion. His whole study is his preservation, although nearly as indefatigable, and actually more swift than the wolf, he does not entirely trust to either, but makes himself an asylum, to which he retires in case of necessity, where he shelters himself from danger, and brings up his young.

As among men, those who lead a domestic life are more civilized and more endued with wisdom than those who

* Buffon, Renard

wander from place to place so in the inferior ranks of animated nature the taking possession of a home supposes a degree of instinct which others are without *. The choice of the situation for this domicile the art of making it convenient of hiding its entrance and securing it against more powerful animals are all so many marks of superior skill and industry. The fox is furnished with both and turns them to his advantage. He generally keeps his kennel at the edge of the wood and yet within an easy journey of some neighbouring cottage. From thence he listens to the crowing of the cock and the cackling of the domestic fowls. He sees them at a distance he seizes his opportunity conceals his approaches creeps slyly along makes the attack and seldom returns without his booty. If he be able to get into the yard he begins by levelling all the poultry without remorse and carrying off a part of the spoil hides it at some convenient distance and again returns to the charge. Taking off another fowl in the same manner he hides that also but not in the same place and thus he practises for several times together until the approach of day or the noise of the domestics give him warning to retire. The same arts are practised when he finds birds entangled in springes laid for them by the fowler the fox takes care to be beforehand very expertly takes the bird out of the snare hides it for three or four days and knows very exactly when and where to return to avail himself of the hidden treasure. He is equally alert in seizing the young hares and rabbits before they have strength enough to escape him and when the old ones are wounded and fatigued he is sure to come upon them in their moments of distress and to shew them no mercy. In the same manner he finds out birds nests seizes the partridge and the quail while sitting and destroys a large quantity of game. The wolf is most hurtful to the peasant but the fox to the gentleman. In short nothing that can be eaten seems to come amiss rats mice serpents toads and lizards. He will when urged by hunger eat vegetables and insects and those that live near the sea coasts will for want of other food eat crabs shrimps and shell fish. The hedge hog in vain rolls itself up into a ball to oppose him this determined glutton tenses it until it is obliged to appear

* Buffon Renard

uncovered, and then he devours it. The wasp and the wild-bee are attacked with equal success. Although at first they fly out upon their invader, and actually oblige him to retire, this is but for a few minutes, until he has rolled himself upon the ground, and thus crushed such as stick to his skin, he then returns to the charge, and at last, by perseverance, obliges them to abandon their combs, which he greedily devours, both wax and honey.

The chase of the fox requires less preparation than that of the wolf, and it is also more pleasant and amusing. As dogs have a natural repugnance to pursue the wolf, so they are equally averse to following the fox, which they prefer even to the chase of the hare or the buck. The huntsmen, as upon other occasions, have their cant terms for every part of this chase. The fox the first year is called *a cub*, the second, *a fox*, and the third, an *old fox*, his tail is called the *brush* or *diag*, and his excrement, the *bulking*. He is usually pursued by a large kind of harrier or hound, assisted by terriers, or a smaller breed, that follow him into his kennel, and attack him there. The instant he perceives himself pursued, he makes to his kennel, and takes refuge at the bottom of it, where for a while he loses the cry of his enemies, but the whole pack coming to the mouth, redouble their vehemence and rage, and the little terrier boldly ventures in. It happens that the kennel is made under a rock, or among the roots of old trees; and in such cases the fox cannot be dug out, nor is the terrier able to contend with him at the bottom of his hole. By this contrivance he continues secure, but when he can be dug out, the usual way is to carry him in a bag to some open country, and there set him loose before the hounds. The hounds and the men follow, barking and shouting wherever he runs, and the body being strongly employed, the mind has not time to make any reflection on the futility of the pursuit. What adds to this entertainment is the strong scent which the fox leaves, that always keeps up a full cry, although as his scent is stronger than that of the hare, it is much sooner evaporated. His shifts to escape, when all retreat is cut off to his kennel, are various and surprising. He always chooses the most woody country, and takes those paths that are most embarrassed with thorns and briars. He does not double, nor use the unavailing shifts of the hare, but flies in a direct

line before the hounds though at no very great distance, manages his strength takes to the low and plishy grounds where the scent will be less apt to lie and at last when overtaken he defends himself with desperate obstinacy and fights in silence to the very last gasp.

The fox though resembling the dog in many respects is nevertheless very distinct in his nature refusing to engender with it and though not testifying the antipathy of the wolf yet discovering nothing more than an indifference. This animal also brings forth fewer at a time than the dog and that but once a year. Its litter is generally from four to six and seldom less than three. The female goes with young about six weeks and seldom stirs out while pregnant but makes a bed for her young and takes every precaution to prepare for their production. When she finds the place of their retreat discovered and that her young have been disturbed during her absence she removes them one after the other in her mouth and endeavours to find them out a place of better security. A remarkable instance of this animal's parental affection happened while I was writing this history in the county of Essex. A she fox that had as it should seem but one cub was unkennelled by a gentleman's hounds near Chelmsford and hotly pursued. In such cases when her own life was in imminent peril one would think it was not a time to consult the safety of her young however the poor animal braving every danger rather than leave her cub behind to be worried by the dogs took it up in her mouth and ran with it in this manner for some miles. At last taking her way through a farmer's yard she was assailed by a mastiff and at last obliged to drop her cub which was taken up by the farmer. I was not displeased to hear that this faithful creature escaped the pursuit and at last got off in safety. The cubs of the fox are born blind like those of the dog they are eighteen months or two years in coming to perfection and live about twelve or fourteen years.

As the fox makes war upon all animals so all others seem to make war upon him. The dog hunts him with peculiar acrimony the wolf is still a greater and more necessitous enemy who pursues him to his very retreat. Some pretend to say that to keep the wolf away the fox lays it the mouth of its kennel a certain herb to which the wolf has a particular aversion. This which no doubt is a fable at least

shews that these two animals are as much enemies to each other as to all the rest of animated nature. But the fox is not hunted by quadrupeds alone, for the birds, who know him for their mortal enemy, attend him in his excursions, and give each other warning of their approaching danger. The daw, the magpie, and the blackbird, conduct him along, perching on the ledges as he creeps below, and, with their cries and notes of hostility, apprise all other animals to beware, a caution which they perfectly understand, and put into practice. The hunters themselves are often informed by the birds of the place of his retreat, and set the dogs into those thickets where they see them particularly noisy and querulous. So that it is the fate of this petty plunderer to be detested by every rank of animals: all the weaker classes shun, and all the stronger pursue him.

The fox, of all wild animals, is most subject to the influence of climate, and there are found as many varieties in this kind almost as in any of the domestic animals *. The generality of foxes, as is well known, are red, but there are some, though not in England, of a grayish cast, and Mr. Buffon asserts, that the tip of the tail in all foxes is white, which, however, is not so in those of this country. There are only three varieties of this animal in Great Britain, and these are rather established upon a difference of size than of colour or form. The greyhound fox is the largest, tallest, and boldest, and will attack a grown sheep. The mastiff fox is less, but more strongly built. The cur fox is the least and most common, he lurks about hedges and out-houses, and is the most pernicious of the three to the peasant and the farmer.

In the colder countries round the pole, the foxes are of all colours, black, blue, gray, non-gray, silver-gray, white, white with red legs, white with black heads, white with the tip of the tail black, red with the throat and belly entirely white, and lastly with a stripe of black running along the back, and another crossing it at the shoulders †. The common kind, however, is more universally diffused than any of the former, being found in Europe, in the temperate climates of Asia, and also in America, they are very rare in Africa, and in the countries lying under the torrid zone.

* Buffon, Renard

† Ibid

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* Buffon, Renard

† Ibid

within hearing reach in to its assistance. The gazelle or whatever other beast it may be finding itself pursued makes off towards the houses and the towns hoping by that means to deter its pursuers from following but hunger gives the jackal the same degree of boldness that fear gives the gazelle and it pursues even to the verge of the city and often along the streets. The gazelle however by this means most frequently escapes for the inhabitants sallying out often disturb the jackal in the chase and as it hunts by the scent when once driven off it never recovers it again. In this manner we see how experience prompts the gazelle which is naturally a very timid animal and particularly fearful of man to take refuge near him considering him as the least dangerous enemy and often escaping by his assistance.

But man is not the only intruder upon the jackals industry and pursuits. The lion the tiger and the panther whose appetites are superior to their swiftness attend to its call and follow in silence at some distance behind *. The jackal pursues the whole night with unceasing assiduity keeping up the cry and with great perseverance at last tires down its prey but just at the moment it supposes itself going to share the fruits of its labour the lion or the leopard comes in strikes himself upon the spoil and his poor provider must be content with the bare carcase he leaves behind. It is not to be wondered at therefore if the jackal be voracious since it so seldom has a sufficiency nor that it feeds on putrid substances since it is not permitted to feast on what it has newly killed. Besides these enemies the jackal has another to cope with for between him and the dog there is an irreconcilable antipathy and they never part without an engagement. The Indian peasants often chase them as we do foxes and have learned by experience when they have got a lion or a tiger in their rear. Upon such occasions they keep their dogs close as they would be no match for such formidable animals and endeavour to put them to flight with their cries. When the lion is dismissed they more easily cope with the jackal who is as stupid as it is impudent and seems much better fitted for pursuing than retreating. It sometimes happens that one of them steals silently into

an out-house, to seize the poultry, or devour the furniture; but hearing others in full cry at a distance, without thought, it instantly answers the call, and thus betrays its own depredations. The peasants sally out upon it, and the foolish animal finds, too late, that its instinct was too powerful for its safety.

THE ISATIS

As the jackal is a sort of intermediate species between the dog and the wolf,* so the isatis may be considered as placed between the dog and the fox. This animal has hitherto been supposed to be only a variety of the latter; but from the latest observations, there is no doubt of their being perfectly distinct. The isatis is very common in all the northern countries bordering upon the Icy Sea; and is seldom found, except in the coldest countries. It extremely resembles the fox, in the form of its body, and the length of its tail, and a dog, in the make of its head and the position of its eyes. The hair of these animals is softer than that of a common fox, some are blue, some are white at one season, and at another of a russet brown. Although the whole of its hair be two inches long, thick, tufted, and glossy, yet the under jaw is entirely without any, and the skin appears bare in that part.

This animal can bear only the coldest climates, and is chiefly seen along the coasts of the Icy Sea, and upon the banks of the great rivers that discharge themselves therein. It is chiefly fond of living in the open country, and seldom seen in the forest, being mostly found in the mountainous and naked regions of Norway, Siberia, and Lapland. It burrows like the fox, and, when with young, the female retires to her kennel, in the same manner as the fox is seen to do. These holes, which are very narrow, and extremely deep, have many outlets. They are kept very clean, and are bedded at the bottom with moss, for the animal to be more at its ease. Its manner of coupling, time of gestation, and number of young, are all similar to what is found in the fox; and it usually brings forth at the end of May or the beginning of June.

Such are the particulars in which this animal differs from those of the dog kind, and in which it resembles

* In this description I have followed Mr Buffon

them but its most striking peculiarity remains still to be mentioned namely its changing its colour and being seen at one time brown and at another perfectly white — As was already said some are naturally blue and their colour never changes but such as are to be white are when brought forth of a yellow hue which in the beginning of September is changed to white all except along the top of the back along which runs a stripe of brown and another crossing it down the shoulders at which time the animal is called the *crossed fox* however this brown cross totally disappears before winter and then the creature is all over white and its fur is two inches long this about the beginning of May again begins to fall and the moulting is completed about the middle of July when the skin becomes brown once more The fur of this animal is of no value unless it be killed in winter

THE HYENA

THE hyena is the last animal I shall mention among those of the dog kind which it in many respects resembles although too strongly marked to be strictly reduced to any type The hyena is nearly of the size of a wolf and has some similitude to that animal in the shape of its head and body The head at first sight does not appear to differ except that the ears of the hyena are longer and more without hair but upon observing more closely we shall find the head broader the nose flatter and not so pointed The eyes are not placed obliquely but more like those of a dog The legs particularly the hinder are longer than those either of the dog or the wolf and different from all other quadrupeds in having but four toes as well on the fore feet as on the hinder Its hair is of a dirty grayish mottled with black disposed in waves down its body Its tail is short with pretty long hair and immediately under it above the anus there is an opening into a kind of glandular pouch which separates a substance of the consistence but not of the odour of civet This opening might have given rise to the error of the ancients who asserted that this animal was every year alternately male and female Such are the most striking distinctions of the hyæna as given us by naturalists

which, nevertheless, convey but a very confused idea of the peculiarity of its form. Its manner of holding the head seems remarkable; somewhat like a dog pursuing the scent, with the nose near the ground. The head being held thus low, the back appears elevated, like that of the hog, which, with a long bushy band of hair that runs all along, gives it a good deal the air of that animal, and, it is probable, that from this similitude it first took its name, the word *huorna* being Greek, and derived from *hus*, which signifies a *sow*.

But no words can give an adequate idea of this animal's figure, deformity, and fierceness, more savage and untamable than any other quadruped, it seems to be for ever in a state of rage or rapacity, for ever growling, except when receiving its food. Its eyes then glisten, the bristles of its back all stand upright, its head hangs low, and yet its teeth appear; all which give it a most frightful aspect, which a dreadful howl tends to heighten. This, which I have often heard, is very peculiar: its beginning resembles the voice of a man moaning, and its latter part as if he were making a violent effort to vomit. As it is loud and frequent, it might, perhaps, have been sometimes mistaken for that of a human voice in distress, and have given rise to the accounts of the ancients, who tell us, that the hyæna makes its moan to attract unwary travellers, and then to destroy them. However this be, it seems the most untractable, and, for its size, the most terrible of all other quadrupeds, nor does its courage fall short of its ferocity, it defends itself against the lion, is a match for the panther, attacks the ounce, and seldom fails to conquer.

It is an obscene and solitary animal, to be found chiefly in the most desolate and uncultivated parts of the torrid zone, of which it is a native*. It resides in the caverns of mountains, in the clefts of rocks, or in dens that it has formed for itself under the earth. Though taken never so young, it cannot be tamed, it lives by depredation, like the wolf, but is much stronger, and more courageous. It sometimes attacks man, carries off cattle, follows the flock, breaks open the sheep-cots by night, and ravages with insatiable voracity. Its eyes shine by night; and it is asserted, not without great appearance of truth, that it sees

* Buffon.

better by night than by day When destitute of other provision it scrapes up the graves and devours the dead bodies how putrid soever To these dispositions which are sufficiently noxious and formidable the ancients have added numberless others which are long since known to be fables as for instance that the hyena was male and female alternately that having brought forth and suckled its young it then changed sexes for a year, and became a male This as was mentioned above could only proceed from the opening under the tail which all animals of this species are found to have and which is found in the same manner in no other quadruped except the badger There is in the weasel kind indeed an opening but it is lower down and not placed above the anus as in the badger and the hyena Some have said that this animal changed the colour of its hair at will others that a stone was found in its eye which put under a man's tongue gave him the gift of prophecy some have said that it had no joints in the neck which however all quadrupeds are known to have and some that the shadow of the hyena kept dogs from barking These among many other absurdities have been asserted of this quadruped and which I mention to shew the natural disposition of mankind, to load those that are already but too guilty with accumulated reproach

CHAP III

OF ANIMALS OF THE WEASEL KIND

HAVING described the bolder ranks of carnivorous animals we now come to a minuter and more feeble class less formidable indeed than any of the former but far more numerous and in proportion to their size more active and enterprising The weasel kind may be particularly distinguished from other carnivorous animals by the length and slenderness of their bodies which are so fitted as to wind like worms in a very small openings after their prey and hence also they have received the name of vermin from their similitude to the worm in this particular These animals differ from all of the cat kind in the formation and disposition of their claws which as in the dog

kinds, they can neither draw in nor extend at pleasure, as cats are known to do. They differ from the dog kind, in being clothed rather with fur than hair, and although some varieties of the fox may resemble them in this particular, yet the coat of the latter is longer, stronger, and always more resembling hair. Beside these distinctions, all animals of the weasel kind have glands placed near the anus, that either open into or beneath it, furnishing a substance that, in some, has the most offensive smell in nature, in others, the most pleasing perfume. All of this kind are still more marked by their habitudes and dispositions, than their external form, cruel, voracious, and cowardly, they subsist only by theft, and find their chief protection in their minuteness. They are all, from the shortness of their legs, slow in pursuit, and, therefore, owe their support to their patience, assiduity, and cunning. As their prey is precarious, they live a long time without food, and if they happen to fall in where it is in plenty, they instantly destroy all about them before they begin to satisfy their appetite, and suck the blood of every animal before they begin to touch its flesh.

These are the marks common to this kind, all the species of which have a most striking resemblance to each other; and he that has seen one, in some measure may be said to have seen all. The chief distinction in this numerous class of animals, is to be taken from the size, for no words can give the minute irregularities of that outline by which one species is to be distinguished from that which is next it. I will begin, therefore, with the least and the best known of this kind, and still marking the size, will proceed gradually to larger and larger, until we come from the weasel to the glutton, which I take to be the largest of all. The weasel will serve as a model for all the rest, and, indeed, the points in which they differ from this little animal, are but very inconsiderable.

The WEASEL,* as was said, is the smallest of this numerous tribe, its length not exceeding seven inches, from the tip of the nose to the insertion of the tail. This length, however, seems to be very great, if we compare it with the height of the animal, which is not above an inch and a half. In measuring the wolf, we find him to be not above

* British Zoology, vol 1 p 83.

once and a half as long as he is high, in observing the weasel we find it near five times as long as it is high which shews an amazing disproportion. The tail also which is bushy is two inches and a half long and adds to the apparent length of this little animal's body. The colour of the weasel is a pale reddish brown on the back and sides but white under the throat and the belly. It has whiskers like a cat and thirty two teeth which is two more than any of the cat kind and these also seem better adapted for tearing and chewing than those of the cat are. The eyes are little and black. The ears short broad and roundish and have a fold at the lower part which makes them look as if they were double. Beneath the corners of the mouth on each jaw is a spot of brown.

This animal though very diminutive to appearance is nevertheless a very formidable enemy to quadrupeds an hundred times its own size. It is very common and well known in most parts of this country but seems held in very different estimation in different parts of it. In those places where sheep or lambs are bred the weasel is a most noxious inmate and every art is used to destroy it on the contrary in places where agriculture is chiefly followed the weasel is considered as a friend that thins the number of such vermin as chiefly live upon corn. However in all places it is one of the most untameable and untractable animals in the world *. When kept in a cage either for the purposes of amusement or inspection it will not touch any part of its victuals while any body looks on. It keeps in a continual agitation and seems frightened so much at the sight of mankind that it will die if not permitted to hide itself from their presence. For this purpose it must be provided in its cage with a sufficient quantity of wool or hay in which it may conceal itself and where it may carry whatever it has got to eat which however it will not touch until it begins to putrefy. In this state it is seen to pass three parts of the day in sleeping and reserves the night for its times of exercise and eating.

In its wild state the night is likewise the time during which it may be properly said to live. At the approach of evening it is seen stealing from its hole and creeping

* Buffon vol xv p 37

about the farmer's yard for its prey. If it enters the place where poultry are kept, it never attacks the cocks or the old hens, but immediately aims at the young ones. It does not eat its prey on the place, but, after killing it by a single bite near the head, and with a wound so small that the place can scarcely be perceived, it carries it off to its young, or its retreat. It also breaks and sucks the eggs, and sometimes kills the hen that attempts to defend them. It is remarkably active, and, in a confined place, scarcely any animal can escape it. It will run up the sides of walls with such facility, that no place is secure from it; and its body is so small, that there is scarcely any hole but what it can wind through. During the summer, its excursions are more extensive; but in winter, it chiefly confines itself in barns and farm-yards, where it remains till spring, and where it brings forth its young. All this season it makes war upon the rats and mice, with still greater success than the cat, for being more active and slender, it pursues them into their holes, and, after a short resistance, destroys them. It creeps also into pigeon-holes, destroys the young, catches sparrows, and all kinds of small birds; and, if it has brought forth its young, hunts with still greater boldness and avidity. In summer, it ventures farther from the house, and particularly goes into those places where the rat, its chiefest prey, goes before it. Accordingly, it is found in the lower grounds, by the side of waters, near mills, and is often seen to hide its young in the hollow of a tree.

The female takes every precaution to make an easy bed for her little ones. She lines the bottom of her hole with grass, hay, leaves, and moss, and generally brings forth from three to five at a time. All animals of this, as well as those of the dog kind, bring forth their young with closed eyes, but they very soon acquire strength sufficient to follow the dam in her excursions, and assist in her projects of petty rapine. The weasel, like all others of its kind, does not run on equably, but moves by bounding, and when it climbs a tree, by a single spring it gets a good way from the ground. It jumps in the same manner upon its prey, and, having an extremely limber body, evades the attempts of much stronger animals to seize it.

This animal, like all of its kind, has a very strong smell,

and that of the weasel is peculiarly foetid. This scent is very distinguishable in those creatures when they void their excrement for the glands which furnish this foetid substance which is of the consistence of suet open directly into the orifice of the anus and taint the excrement with the strong effluvia. The weasel smells more strongly in summer than in winter and more abominably when irritated or pursued than when at its ease. It always preys in silence and never has a cry except when struck, and then it has a rough kind of squerking which at once expresses resentment and pain. Its appetite for animal food never forsakes it and it seems even to take a pleasure in the vicinity of putrefaction. Mr Buffon tells us of one of them being found with three young ones in the carcass of a wolf that was grown putrid and that had been hung up by the hind legs as a terror to others. Into this horrid retreat the weasel thought proper to retire to bring forth her young she had furnished the cavity with hay grass and leaves and the young were just brought forth when they were discovered by a peasant passing that way.

THE ERMINE, OR STOAT

NEXT to the weasel in size and perfectly alike in figure is the ermine. The difference between this and the former animal is so very small that many and among the rest Linnæus who gives but one description of both have confounded the two kinds together. However their differences are sufficient to induce later naturalists to suppose the two kinds distinct and as their lights seem preferable we choose to follow their descriptions.*

The stoat or ermine differs from the weasel in size being usually nine inches long whereas the former is not much above six. The tail of the ermine is always tipped with black is longer in proportion to the body and more furnished with hair. The edges of the ears and the ends of the toes in this animal are of a yellowish white and although it is of the same colour with the weasel being of a lightish brown and though both this animal as well as the weasel in the most northern parts of Europe changes

* Buffon British Zoology

its colour in winter, and becomes white; yet even then the weasel may be easily distinguished from the ermine by the tip of the tail, which in the latter is always black.

It is well known that the fur of the ermine is the most valuable of any hitherto known; and it is in winter only that this little animal has it of the proper colour and consistence. In summer, the ermine, as was said before, is brown, and it may at that time more properly be called the *stoat*. There are few so unacquainted with quadrupeds as not to perceive this change of colour in the hair, which, in some degree, obtains in them all. The horse, the cow, and the goat, all manifestly change colour in the beginning of summer, the old long hair falling off, and a shorter coat of hair appearing in its room, generally of a darker colour, and yet more glossy. What obtains in our temperate climate is seen to prevail still more strongly in those regions where the winters are long and severe, and the summers short, and yet generally hot in an extreme degree. The animal has strength enough during that season to throw off a warm coat of fur, which would but incommode it, and continues for two or three months in a state somewhat resembling the ordinary quadrupeds of the milder climates. At the approach of winter, however, the cold increasing, the coat of hair seems to thicken in proportion; from being coarse and short, it lengthens and grows finer, while multitudes of smaller hairs grow up between the longer, thicken the coat, and give it all that warmth and softness which are so much valued in the furs of the northern animals.

It is no easy matter to account for this remarkable warmth of the furs of northern quadrupeds, or how they come to be furnished with such an abundant covering. It is easy enough, indeed, to say that Nature fits them thus for the climate; and like an indulgent mother, when she exposes them to the rigour of an intemperate winter, supplies them with a covering against its inclemency. But this is only flourishing: it is not easy, I say, to tell how Nature comes to furnish them in this manner. A few particulars on this subject are all that we yet know. It is observable among quadrupeds, as well as even among the human species itself, that a thin sparing diet is apt to produce hair; children that have been ill fed, famished dogs and horses, are more hairy than others whose food has been more plentiful. This may,

therefore be one cause that the animals of the north in winter are more hairy than those of the milder climates. At that season the whole country is covered with deep snow and the provisions which these creatures are able to procure can be but precarious and scanty. Its becoming finer may also proceed from the severity of the cold that contracts the pores of the skin and the hair consequently takes the shape of the aperture through which it grows, as wires are made smaller by being drawn through a smaller orifice. However this may be all the animals of the arctic climates may be said to have their winter and summer garments except very far to the north as in Greenland where the cold is so continually intense and the food so scarce, that neither the bears nor foxes change colour *

The ermine as was said is remarkable among these for the softness the closeness and the warmth of its fur. It is brown in summer like the weasel and changes colour before the winter is begun becoming a beautiful cream colour all except the tip of the tail as was said before which still continues black. Mr Daubenton had one of these brought him with its white winter fur, which he put into a cage and kept in order to observe the manner of moulting its hair. He received it in the beginning of March in a very short time it began to shed its coat and a mixture of brown was seen to prevail among the white so that at the ninth of the same month its head was nearly become of a reddish brown. Day after day this colour appeared to extend at first along the neck and down the back in the manner of a stripe of about half an inch broad. The fore part of the legs then assumed the same colour a part of the head the thighs and the tail were the last that changed but at the end of the month there was no white remaining except on those parts which are always white in this species particularly the throat and the belly. However he had not the pleasure of seeing this animal resume its former whiteness although he kept it for above two years, which without doubt was owing to its imprisoned state this colour being partly owing to its stunted food and partly to the rigour of the season. During its state of confinement this little animal always continued very wild and untractable forever in a

state of violent agitation, except when asleep, which it often continued for three parts of the day. Except for its most disagreeable scent, it was an extremely pretty creature, its eyes sprightly, its physiognomy pleasant, and its motions so swift that the eye could scarcely attend them. It was fed with eggs and flesh, but it always let them putrefy before it touched either. As some of this kind are known to be fond of honey, it was tried to feed this animal with such food for a while; after having, for three or four days, deprived it of other food, it ate of this, and died shortly after; a strong proof of its being a distinct species from the pole-cat or the martin, who feed upon honey, but otherwise pretty much resemble the ermine in their figure and dispositions.

In the north of Europe and Siberia their skins make a valuable article of commerce, and they are found there much more frequently than among us. In Siberia they burrow in the fields, and are taken in traps baited with flesh. In Norway they are either shot with blunt arrows, or taken in traps made of two flat stones, one being propped with a stick, to which is fastened a baited string, and when the animals attempt to pull this away, the stone drops and crushes them to death. This animal is sometimes found white in Great Britain, and is then called a white weasel. Its furs, however, among us are of no value, having neither the thickness, the closeness, nor the whiteness, of those which come from Siberia. The fur of the ermine, in every country, changes by time; for, as much of its beautiful whiteness is given it by certain arts known to the furriers, so its natural colour returns, and its former whiteness can never be restored again.

THE FERRET.

THE animal next in size to the ermine is the ferret; which is a kind of domestic in Europe, though said to be originally brought from Africa into Spain, which being a country abounding in rabbits, required an animal of this kind more than any other: however this be, it is not to be found at present among us, except in its domestic state; and it is chiefly kept tame, for the purposes of the warren.

The ferret is about one foot long, being nearly four inches longer than the weasel. It resembles that animal in the

slenderness of its body and the shortness of its legs but its nose is sharper and its body more slender, in proportion to its length. The ferret is commonly of a cream colour, but they are also found of all the colours of the weasel kind white blackish brown, and party coloured. Those that are of the whitish kind have their eyes red, as is almost general with all animals entirely of that colour. But its principal distinction from the weasel is the length of the hair on its tail which is much longer in the ferret than the weasel. Words will not well express the other distinctions and what might take up a page in dull discrimination a single glance of the eye when the animals themselves are presented can discover.

As this animal is a native of the torrid zone * so it cannot bear the rigours of our climate without care and shelter, and it generally repays the trouble of its keeping by its great agility in the warren. It is naturally such an enemy of the rabbit kind that if a dead rabbit be presented to a young ferret although it has never seen one before it instantly attacks and bites it with an appearance of rapacity. If the rabbit be living the ferret is still more eager seizes it by the neck winds itself round it and continues to suck its blood till it be satiated.

Their chief use in warrens is to enter the holes and drive the rabbits into the nets that are prepared for them at the mouth. For this purpose the ferret is muzzled otherwise instead of driving out the rabbit it would content itself with killing and sucking its blood at the bottom of the hole but by this contrivance being rendered unable to seize its prey the rabbit escapes from its claws and instantly makes to the mouth of the hole with such precipitation that it is inextricably entangled in the net placed there for its reception. It often happens however that the ferret disengages itself of its muzzle and then it is most commonly lost unless it be dug out for finding all its wants satisfied in the warren it never thinks of returning to the owner but continues to lead a rapacious solitary life while the summer continues and dies with the cold of the winter. In order to bring the ferret from his hole the owners often burn straw and other substances at the mouth.

they also beat above to terrify it: but this does not always succeed; for as there are often several issues to each hole, the ferret is affected neither by the noise nor the smoke, but continues secure at the bottom, sleeping the greatest part of the time, and waking only to satisfy the calls of hunger.

The female of this species* is sensibly less than the male, whom she seeks with great ardour, and, it is said, often dies without being admitted. They are usually kept in boxes, with wool, of which they make themselves a warm bed, that serves to defend them from the rigour of the climate. They sleep almost continually; and the instant they awake, they seem eager for food. They are usually fed with bread and milk. They breed twice a year. Some of them devour their young as soon as brought forth, and then become fit for the male again. Their number is usually from five to six at a litter; and this is said to consist of more females than males. Upon the whole, this is an useful, but a disagreeable and offensive animal; its scent is foetid, its nature voracious, it is tame without any attachment, and such is its appetite for blood, that it has been known to attack and kill children in the cradle. It is very easy to be irritated, and, although at all times its smell is very offensive, it then is much more so; and its bite is very difficult of cure.

To the ferret kind we may add an animal which Mr. Buffon calls the *vansire*, the skin of which was sent him stuffed from Madagascar. It was thirteen inches long, a good deal resembling the ferret in figure, but differing in the number of its grinding-teeth, which amounted to twelve; whereas in the ferret there are but eight. It differed also in colour, being of a dark brown, and exactly the same on all parts of its body. Of this animal, so nearly resembling the ferret, we have no other history but the mere description of its figure; and in a quadruped whose kind is so strongly marked, perhaps this is sufficient to satisfy curiosity.

* Buffon.

THE POLECAT

THE Polecat is larger than the weasel the ermine, or the ferret, being one foot five inches long whereas the weasel is but six inches the ermine nine and the ferret eleven inches. It so much resembles the ferret in form that some have been of opinion they were one and the same animal, nevertheless there are a sufficient number of distinctions between them. It is in the first place larger than the ferret. It is not quite so slender and has a blunter nose. It differs also internally having but fourteen ribs whereas the ferret has fifteen and wants one of the breast bones which is found in the ferret. However warreners assert that the polecat will mix with the ferret and they are sometimes obliged to procure an intercourse between these two animals to improve the breed of the latter which by long confinement is sometimes seen to abate of its rapacious disposition. Mr Buffon denies that the ferret will admit the polecat yet gives a variety under the name of both animals which may very probably be a spurious race between the two.

However this be, the polecat seems by much the more pleasing animal of the two for although the long slender shape of all these vermin tribes gives them a very disagreeable appearance yet the softness and colour of the hair in some of them atones for the defect and renders them if not pretty at least not frightful. The polecat for the most part is of a deep chocolate colour. It is white about the mouth the ears are short rounded and tipped with white a little beyond the corners of the mouth a stripe begins which runs backward partly white and partly yellow its hair like that of all this class is of two sorts the long and the furry but in this animal the two kinds are of different colours the longest is black and the shorter yellowish * the throat feet and tail are blcker than any other parts of the body the claws are white underneath and brown above and its tail is about two inches and a half.

It is very destructive to young game of all kinds,† but

* Ray's Synopsis

† British Zoology vol. 1 p. 78

the rabbit seems to be its favourite prey: a single polecat is often sufficient to destroy a whole warren; for, with that insatiable thirst for blood which is natural to all the weasel kind, it kills much more than it can devour; and I have seen twenty rabbits at a time taken out dead, which they had destroyed, and that by a wound which was hardly perceptible. Their size, however, which is so much larger than the weasel, renders their retreats near houses much more precarious; although I have seen them burrow near a village, so as scarcely to be extirpated. But, in general, they reside in woods or thick brakes, making holes under ground of about two yards deep, commonly ending among the roots of large trees, for greater security. In winter they frequent houses, and make a common practice of robbing the hen-roost and the dairy.

The polecat is particularly destructive among pigeons,* when it gets into a dove-house; without making so much noise as the weasel, it does a great deal more mischief; it dispatches each with a single wound in the head; and, after killing a great number, and satiating itself with their blood, it then begins to think of carrying them home. This it carefully performs, going and returning, and bringing them one by one to its hole; but if it should happen that the opening by which it got into the dove-house be not large enough for the body of the pigeon to get through, this mischievous creature contents itself with carrying away the heads, and makes a most delicious feast upon the brains.

It is not less fond of honey; attacking the hives in winter, and forcing the bees away. It does not remove far from houses in winter, as its prey is not so easily found in the woods during that season. The female brings forth her young in summer, to the number of five or six at a time; these she soon trains to her own rapacious habits, supplying the want of milk, which no carnivorous quadruped has in plenty, with the blood of such animals as she happens to seize. The fur of this animal is considered as soft and warm; yet it is in less estimation than some of a much inferior kind, from its offensive smell, which can never be wholly removed or suppressed. The polecat seems to be an

* Buffon

inhabitant of the temperate climates * scarcely any being found towards the north and but very few in the warmer latitudes. The species appears to be confined in Europe from Poland to Italy. It is certain that these animals are afraid of the cold as they are often seen to come into houses in winter and as their tracks are never found in the snow near their retreats. It is probable also that they are afraid of heat as they are but thinly scattered in the southern climates.

THE MARTIN

THE Martin is a larger animal than any of the former being generally eighteen inches long and the tail ten more. It differs from the polecat in being about four or five inches longer its tail also is longer in proportion and more bushy at the end its nose is flatter its cry is sharper and more piercing its colours are more elegant and what still adds to their beauty its scent very unlike the former instead of being offensive, is considered as a most pleasing perfume. The martin in short is the most beautiful of all British beasts of prey, its head is small and elegantly formed its eyes lively, its ears are broad rounded and open its back its sides and tail, are covered with a fine thick downy fur with longer hair intermixed the roots are ash colour the middle of a bright chesnut the points black the head is brown with a slight cast of red the legs and upper sides of the feet are of a chocolate colour the palms or under sides are covered with a thick down like that of the body the feet are broad the claws white large and sharp well adapted for the purposes of climbing but as in others of the weasel kind incapable of being sheathed or unsheathed at pleasure the throat and breast are white the belly of the same colour with the back but rather paler the hair on the tail is very long especially at the end where it appears much thicker than near the insertion.

There is also a variety of this animal called the *yellow breasted martin* which in no respect differs from the former except that this has a yellow breast whereas the other has

* Buffon

a white one: the colour of the body also is darker; and, as it lives more among trees than the other martin, its fur is more valuable, beautiful, and glossy. The former of these Mr Buffon calls the *fouine*, the latter, simply the *martin*; and he supposes them to be a distinct species: but as they differ only in colour, it is unnecessary to embarrass history by a new distinction, where there is only so minute a difference.

Of all animals of the weasel kind, the martin is the most pleasing; all its motions shew great grace, as well as agility; and there is scarcely an animal in our woods that will venture to oppose it. Quadrupeds five times as big are easily vanquished; the hare, the sheep, and even the wild cat itself, though much stronger, is not a match for the martin: and although carnivorous animals are not fond of engaging each other, yet the wild cat and the martin seldom meet without a combat. Gesner tells us of one of this kind that he kept tame, which was extremely playful and pretty; it went among the houses of the neighbourhood, and always returned home when hungry: it was extremely fond of a dog that had been bred up with it, and used to play with it as cats are seen to play, lying on its back, and biting without anger or injury. That which was kept tame by Mr. Buffon, was not quite so social: it was divested of its ferocity, but continued without attachment; and was still so wild as to be obliged to be held by a chain. Whenever a cat appeared, it prepared for war; and if any of the poultry came within its reach, it flew upon them with avidity. Though it was tied by the middle of the body, it frequently escaped: at first it returned after some hours, but without seeming pleased, and as if it only came to be fed; the next time it continued abroad longer; and, at last, went away without ever returning. It was a female, and was, when it went off, a year and a half old, and Mr Buffon supposes it to have gone in quest of the male. It ate every thing that was given it, except salad or herbs; and it was remarkably fond of honey. It was remarked, that it drank often, and often slept for two days together; and that, in like manner, it was often two or three days without sleeping. Before it went to sleep, it drew itself up into a round, hid its head, and covered it with its tail. When awake it was in continual agitation, and was obliged

to be tied up not less to prevent its attacking the poultry than to hinder it from breking whatever it came near by the capricious wildness of its motions

The yellow breasted martin is much more common in France than in England, and yet even there this variety is much scarcer than that with the white breast. The latter keeps nearer houses and villages to make its petty ravages among the sheep and the poultry the other keeps in the woods and leads in every respect a savage life building its nest on the tops of trees and living upon such animals as are entirely wild like itself. About night fall it usually quits its solitude to seek its prey hunts after squirrels rats and rabbits destroys great numbers of birds and their young takes the eggs from the nest and often removes them to its own without breaking *. The instant the martin finds itself pursued by dogs for which purpose there is a peculiar breed that seem fit for this chase only it immediately makes to its retreat which is generally in the hollow of some tree towards the top and which it is impossible to come at without cutting it down. Their nest is generally the original tenement of the squirrel which that little animal bestowed great pains in completing but the martin having killed and dispossessed the little architect takes possession of it for its own use enlarges its dimensions improves the softness of the bed and in that retreat brings forth its young. Its litter is never above three or four at a time they are brought forth with the eyes closed as in all the rest of this kind and very soon come to a state of perfection. The dam compensates for her own deficiency of milk by bringing them eggs and live birds accustoming them from the beginning to a life of carnage and rapine. When she leads them from the nest into the woods the birds at once distinguish their enemies and attend them as we before observed of the fox with all the marks of alarm and animosity. Wherever the martin conducts her young a flock of small birds are seen threatening and insulting her alarming every thicket and often directing the hunter in his pursuit. The martin is more common in North America than in any part of Europe. These animals are found in all the northern parts of the world from Siberia to China and Canada. In every country they are hunted

* Brakes's Natural History

for their furs, which are very valuable, and chiefly so when taken in the beginning of winter. The most esteemed part of the martin's skin is that part of it which is browner than the rest, and stretches along the backbone. Above twelve thousand of these skins are annually imported into England from Hudson's Bay, and above thirty thousand from Canada.

THE SABLE.

Most of the classes of the weasel kind would have continued utterly unknown and disregarded, were it not for their furs, which are finer, more glossy, and soft, than those of any other quadruped. Their dispositions are fierce and untameable; their scent generally offensive; and their figure disproportioned and unpleasing. The knowledge of one or two of them would, therefore, have sufficed curiosity, and the rest would probably have been confounded together under one common name, as things useless and uninteresting, had not their skins been coveted by the vain, and considered as capable of adding to human magnificence or beauty.

Of all these, however, the skin of the sable is the most coveted, and held in the highest esteem. It is of a brownish black; and the darker it is it becomes the more valuable. A single skin, though not above four inches broad, is often valued at ten or fifteen pounds,* the fur differing from others in this, that it has no grain; so that rub it which way you will, it is equally smooth and unresisting. Nevertheless, though this little animal's robe was so much coveted by the great, its history till of late was but very little known; and we are obliged to Mr. Jonelin for the first accurate description of its form and nature.† From him we learn that the sable resembles the martin in form and size, and the weasel in the number of its teeth; for it is to be observed, that whereas the martin has thirty-eight teeth, the weasel has but thirty-four; in this respect, therefore, the sable seems to make the shade between these two animals; being shaped like the one, and furnished with teeth like the other. It is also furnished with very large whiskers about the mouth; its feet are broad, and, as in the rest of

* Regnard

† Buffon, vol xxvi p 113

its kind furnished with five claws on each foot. These are its constant marks but its fur for which it is so much valued is not always the same. Some of this species are of a dark brown over all the body except the ears and the throat where the hair is rather yellow others are more of a yellowish tincture their ears and throat being also much paler. These in both are the colours they have in winter and which they are seen to change in the beginning of the spring the former becoming of a yellow brown and the latter of a pale yellow. In other respects they resemble their kind in vivacity agility and inquietude in sleeping by day and seeking their prey by night, in living upon smaller animals and in the disagreeable odour that chiefly characterizes their race.

They generally inhabit along the banks of rivers in shady places and in the thickest woods. They leap with great ease from tree to tree and are said to be afraid of the sun which tarnishes the lustre of their robes. They are chiefly hunted in winter for their skins during which part of the year they are only in season. They are mostly found in Siberia and but very few in any other country of the world and thus scarcity it is which enhances their value. The hunting of the sable chiefly falls to the lot of the condemned criminals who are sent from Russia into these wild and extensive forests that for the greatest part of the year are covered with snow and in this instance as in many others the luxuries and ornaments of the vain are wrought
 ries of the wretched. These
 number of skins every year
 quantity be not provided.

The sable is also killed by the Russian soldiers who are sent into those parts to that end. They are taxed a certain number of skins yearly like the former and are obliged to shoot with only a single ball to avoid spoiling the skin or else with cross bows and blunt arrows. As an encouragement to the hunters they are allowed to share among themselves the surplus of those skins which they thus procure and this in the process of six or seven years amounts to a very considerable sum. A colonel during his seven years stay gains about four thousand crowns for his share and the common men six or seven hundred each for theirs.

THE ICHNEUMON.

THE ichneumon, which some have injudiciously denominated the *cat of Pharaoh*, is one of the boldest and most useful animals of all the weasel kind. In the kingdom of Egypt, where it is chiefly bred, it is used for the same purposes that cats are in Europe, and is even more serviceable, as being more expert in catching mice than they. This animal is usually of the size of the martin, and greatly resembles it in appearance, except that the hair, which is of a grisly black, is much rougher, and less downy. The tail, also, is not so bushy at the end; and each hair in particular has three or four colours, which are seen in different dispositions of its body. Under its rougher hairs, there is a softer fur of a brownish colour, the rough hair being about two inches long, but that of the muzzle extremely short, as likewise that on the legs and paws. However, being long since brought into a domestic state, there are many varieties in this animal, some being much larger than the martin, others much less; some being of a lighter mixture of colours, and some being streaked in the manner of a cat.

The ichneumon, with all the strength of a cat, has more instinct and agility; a more universal appetite for carnage, and a greater variety of powers to procure it*. Rats, mice, birds, serpents, lizards, and insects, are all equally pursued; it attacks every living thing which it is able to overcome, and indiscriminately preys on flesh of all kinds. Its courage is equal to the vehemence of its appetite. It fears neither the force of the dog, nor the insidious malice of the cat; neither the claws of the vulture, nor the poison of the viper. It makes war upon all kinds of serpents with great avidity, seizes and kills them, how venomous soever they be, and we are told, that when it begins to perceive the effects of their rage, it has recourse to a certain root, which the Indians call after its name, and assert to be an antidote for the bite of the asp or the viper.

But what this animal is particularly serviceable to the Egyptians for, is, that it discovers and destroys the eggs of the crocodile. It also kills the young ones that have not as yet been able to reach the water; and, as fable usually

* The rest of this description is extracted from Mr Buffon, except where marked with commas.

goes hand in hand with truth it is said that the ichneumon sometimes enters the mouth of the crocodile when it is found sleeping on the shore boldly attacks the enemy in the inside and at length when it has effectually destroyed it, eats its way out again

The ichneumon when wild generally resides along the banks of rivers, and in times of inundation makes to the higher ground often approaching inhabited places in quest of prey It goes forward silently and cautiously changing its manner of moving according to its necessities Some times it carries the head high shortens its body and raises itself upon its legs sometimes it lengthens itself and seems to creep along the ground it is often observed to sit upon its hind legs like a dog when taught to beg but more commonly it is seen to dart like an arrow upon its prey and seize it with inevitable certainty Its eyes are sprightly, and full of fire its physiognomy sensible, its body nimble its tail long and its hair rough and various Like all of its kind it has glands that open behind and furnish an odorous substance Its nose is too sharp and its mouth too small to permit its seizing things that are large however it makes up by its courage and activity its want of arms it easily strangles a cat though stronger and larger than itself and often fights with dogs which though never so bold learn to dread the ichneumon as a formidable enemy It also takes the water like the otter and as we are told, will continue under it much longer

This animal grows fast, and dies soon It is found in great numbers in all the southern parts of Asia from Egypt to Java and it is also found in Africa particularly at the Cape of Good Hope It is domestic as was said in Egypt but in our colder climates it is not easy to breed or maintain them as they are not able to support the rigour of our winters Nevertheless they take every precaution that instinct can dictate to keep themselves warm they wrap themselves up into a ball hiding the head between the legs and in this manner continue to sleep all day long

Seba had one sent him from the island of Ceylon which he permitted to run for some months about the house It was heavy and slothful by day and often could not be awakened even with a blow but it made up this indolence by its nocturnal activity smelling about without either

being wholly tame or wholly mischievous. It climbed up the walls and the trees with very great ease, and appeared extremely fond of spiders and worms, which it preferred, probably from their resemblance to serpents, its most natural food. It was also particularly eager to scratch up holes in the ground, and this, added to its wildness and uncleanness, obliged our naturalist to smother it in spirits, in order to preserve, and add it to the rest of his collection."

This animal was one of those formerly worshipped by the Egyptians, who considered every thing that was serviceable to them as an emanation of the Deity, and worshipped such as the best representatives of God below. Indeed, if we consider the number of eggs which the crocodile lays in the sand at a time, which often amount to three or four hundred, we have reason to admire this little animal's usefulness as well as industry in destroying them, since otherwise the crocodile might be produced in sufficient numbers to overrun the whole earth.

THE STINKARDS.

THIS is a name which our sailors give to one or two animals of the weasel kind, which are chiefly found in America. All the weasel kind, as was already observed, have a very strong smell; some of them indeed approaching to a perfume, but the greatest number most insupportably foetid. But the smell of our weasels, and ermines, and polecats, is fragrance itself when compared to that of the *squash* and the *skink*, which have been called the *polecats* of America. These two are found in different parts of America, both differing in colour and fur, but both obviously of the weasel kind, as appears not only from their figure and odour, but also from their disposition. The *squash* is about the size of a polecat, its hair of a deep brown, but principally differing from all of this kind in having only four toes on the feet before, whereas all the other weasels have five. The *skink*, which I take to be Catesby's Virginia polecat, resembles a polecat in shape and size, but particularly differs in the length of its hair and colour. The hair is above three inches and a half long, and that at the end of the tail above four inches. The colour is partly black and partly white, variously

disposed over the body very glossy long and beautiful. There seem to be two varieties more of this animal which Mr Buffon calls the *conepate* and the *zorille*. He supposes each to be a distinct species but as they are both said to resemble the polecat in form and both to be clothed with a long fur of a black and white colour it seems needless to make a distinction. The *conepate* resembles the skink in all things except in size being smaller and in the disposition of its colours which are more exact having five white stripes upon a black ground running longitudinally from the head to the tail. The *zorille* resembles the skink but is rather smaller and more beautifully coloured its streaks of black and white being more distinct and the colours of its tail being black at its insertion and white at the extremity whereas in the skink they are all of one gray colour.

But whatever differences there may be in the figure or colour of these little animals they all agree in one common affection that of being intolerably foetid and loathsome. I have already observed that all the weasel kind have glands furnishing an odorous matter near the anus the conduits of which generally have their aperture just at its opening. That substance which is stored up in these receptacles is in some of this kind such as in the martin already mentioned and also in the genet and the civet to be described hereafter a most grateful perfume but in the weasel the ermine the ferret and the polecat it is extremely foetid and offensive. These glands in the animals now under consideration are much larger and furnish a matter sublimed to a degree of putrescence that is truly amazing. As to the perfumes of musk and civet we know that a single grain will diffuse itself over a whole house and continue for months to spread an agreeable odour without diminution. However the perfume of the musk or the civet is nothing either for strength or duration to the insupportable odour of these. It is usually voided with their excrement and if but a single drop happens to touch any part of a man's garment it is more than probable that he can never wear any part of it more.

In describing the effects produced by the excrement of these animals we often hear of its raising this diabolical smell by its urine. However of this I am apt to doubt,

and it should seem to me, that, as the weasel kind have then excrements so extremely foetid from the cause above-mentioned, we may consider these also as being foetid from the same causes. Besides, they are not furnished with glands to give them urine such a smell, and the analogy between them and the weasel kind being so strong in other respects, we may suppose they resemble each other in this. It has also been said, that they take this method of ejecting their excrement to defend themselves against their pursuers; but it is much more probable that this ejection is the convulsive effect of terror, and that it serves as their defence without their own concurrence. Certain it is, that they never smell thus horribly except when enraged or affrighted, for they are often kept tame about the houses of the planters of America without being very offensive.

The habitudes of all these animals are the same, living like all the rest of the weasel kind, as they prey upon smaller birds and birds' eggs. The squash, for instance, burrows like the pole-cat in the clefts of rocks, where it brings forth its young. It often steals into farm-yards, and kills the poultry, eating only their brains. Nor is it safe to pursue or offend it, for then it calls up all its scents, which are its most powerful protection. At that time neither men nor dogs will offer to approach it, the scent is so strong that it reaches for half a mile round, and more near at hand is almost stifling. If the dogs continue to pursue, it does all in its power to escape, by getting up a tree, or by some such means; but if driven to an extremity, it then lets fly upon the hunters, and if it should happen that a drop of this foetid discharge falls in the eye, the person runs the risk of being blinded for ever.*

The dogs themselves instantly abate of their ardour when they find this extraordinary battery played off against them, they instantly turn tail, and leave the animal undisputed master of the field; and no exhortations can ever bring them to rally. "In the year 1749," says Kalm, "one of these animals came near the farm where I lived. It was in winter time, during the night, and the dogs that were upon the watch pursued it for some time, until

* Voyage de Kalm, as quoted by Buffon, vol. XXVII p. 93.

it discharged against them. Although I was in my bed a good way off I thought I should have been suffocated and the cows and oxen by their lowings shewed how much they were affected by the stench. About the end of the same year another of these animals crept into our cellar but did not exhale the smallest scent because it was not disturbed. A foolish woman however who perceived it at night by the shining of its eyes killed it and at that moment its stench began to spread. The whole cellar was filled with it to such a degree that the woman kept her bed for several days after, and all the bread meat and other provisions that were kept there were so infected that they were obliged to be thrown out of doors. Nevertheless many of the planters and native Americans keep this animal tame about their houses and seldom perceive any disagreeable scents except it is injured or frightened. They are also known to eat its flesh which some assert to be tolerable food however they take care to deprive it of those glands which are so horribly offensive.

THE GENET

FROM the squish which is the most offensive animal in nature we come to the genet, which is one of the most beautiful and pleasing. Instead of the horrid stench with which the former affects us this has a most grateful odour more faint than civet but to some for that reason more agreeable. This animal is rather less than the martin though there are genets of different sizes and I have seen one rather larger. It also differs somewhat in the form of its body. It is not easy in words to give an idea of the distinction. It resembles all those of the weasel kind in its length compared to its height it resembles them in having a soft beautiful fur in having its feet armed with claws that cannot be sheathed and in its appetite for petty carnage. But then it differs from them in having the nose much smaller and longer rather resembling that of a fox than a weasel. The tail also instead of being bushy tapers to a point and is much longer its ears are larger and its paws smaller. As to its colours and figure in general the genet is spotted with black upon a ground

mixed with red and gray. It has two sorts of hair, the one shorter and softer, the other longer and stronger, but not above half an inch long on any part of its body except the tail. Its spots are distinct and separate upon the sides, but unite towards the back, and form black stripes, which run longitudinally from the neck backwards. It has also along the back a kind of mane or longish hair, which forms a black streak from the head to the tail, which last is marked with rings, alternately black and white, its whole length.

The genet, like all the rest of the weasel kinds, has glands, that separate a kind of perfume, resembling civet, but which soon flies off. These glands open differently from those of other animals of this kind; for, as the latter have their apertures just at the opening of the anus, these have their aperture immediately under it; so that the male seems, for this reason, to the superficial observer, to be of two sexes.

It resembles the martin very much in its habits and disposition,* except, that it seems tamed much more easily. Belonius assures us, that he has seen them in the houses at Constantinople as tame as cats, and that they were permitted to run every where about, without doing the least mischief. For this reason they have been called the *cats of Constantinople*, although they have little else in common with that animal, except their skill in spying out and destroying vermin. Naturalists pretend that it inhabits only the moister grounds, and chiefly resides along the banks of rivers, having never been found in mountains, nor dry places. The species is not much diffused, it is not to be found in any part of Europe, except Spain and Turkey, it requires a warm climate to subsist and multiply in; and yet it is not to be found in the warmer regions either of India or Africa. From such as have seen its uses at Constantinople, I learn, that it is one of the most beautiful, cleanly, and industrious animals in the world; that it keeps whatever house it is in perfectly free from mice and rats, which cannot endure its smell. Add to this, its nature is mild and gentle, its colours various and glossy, its fur valuable; and, upon the whole, it seems to be one of those

animals that with proper care might be propagated amongst us and might become one of the most servicable of our domestics

THE CIVET

PROCEEDING from the smaller to the greater of this kind we come in the last place to the Civet which is much larger than any of the former for as the martin is not above sixteen inches long the civet is found to be above thirty Mr Buffon distinguishes this species into two kinds one of which he calls the *civet* and the other the *zibet* The latter principally differs from the former in having the body longer and more slender the nose smaller the ears longer and broader no mane or long hair running down the back in the latter and the tail longer and better marked with rings of different colours from one end to the other These are the differences which have induced this great naturalist to suppose them animals of distinct species and to allot each a separate description How far future experience may confirm this conjecture time must discover but certain it is that if such small varieties make a separate species there may be many other animals equally entitled to peculiar distinction that are now classed together We shall therefore content ourselves at present with considering as former naturalists have done these two merely as varieties of the same animal and only altered in figure by climate food or education

The civet resembles animals of the weasel kind in the long slenderness of its body the shortness of its legs the odorous matter that exudes from the glands behind the softness of its fur the number of its claws and their incapacity of being sheathed It differs from them in being much larger than any hitherto described in having the nose lengthened so as to resemble that of the fox the tail long and tapering to a point and its ears straight like those of a cat The colour of the civet varies it is commonly ash spotted with black though it is whiter in the female tending to yellow and the spots are much larger like those of a panther The colour on the belly and under the throat is black whereas the other parts of the body are black or streaked with gray This animal varies in its colour being

sometimes streaked, as in our kind of cats called *tabbies*. It has whiskers like the rest of its kind; and its eye is black and beautiful.

The opening of the pouch or bag, which is the receptacle of the civet, differs from that of the rest of the weasel kind, not opening into, but under the anus. Besides this opening, which is large, there is still another lower down; but for what purposes designed, is not known. The pouch itself is about two inches and a half broad, and two long, its opening makes a chink, from the top downwards, that is about two inches and a half long, and is covered, on the edges and within, with short hair. When the two sides are drawn asunder, the inward cavity may be seen, large enough to hold a small pullet's egg, all round this are small glands, opening and furnishing that strong perfume which is so well known, and is found in this pouch of the colour and consistence of pomatum. Those who make it their business to breed these animals for their perfume usually take it from them twice or thrice a week, and sometimes oftener. The animal is kept in a long sort of a box, in which it cannot turn round. The person, therefore, opens this box behind, drags the animal backwards by the tail, keeps it in this position by a bar before, and, with a wooden spoon, takes the civet from the pouch, as carefully as he can, then lets the tail go, and shuts the box again. The perfume, thus procured, is put into a vessel, which he takes care to keep shut; and when a sufficient quantity is procured, it is sold to very great advantage.

The civet,* although a native of the warmest climates, is yet found to live in temperate, and even cold countries, provided it be defended carefully from the injuries of the air. Wherefore, it is not only bred among the Turks, the Indians, and Africans, but great numbers of these animals are also bred in Holland, where this scraping people make no small gain of its perfume. The perfume of Amsterdam is reckoned the purest of any; the people of other countries adulterating it with gums, and other matters, which diminish its value, but increase its weight. The quantity which a single animal affords, generally depends upon its health and nourishment. It gives more in proportion as it

* Buffon, vol. vii.

is more delicately and abundantly fed. Raw flesh hashed small eggs rice birds young fowls and particularly fish are the kinds of food the civet most delights in. These are to be changed and altered to suit and entice its appetite and continue its health. It gets but very little water and although it drinks but rarely yet it makes urine very frequently and upon such occasions, we cannot as in other animals distinguish the male from the female.

The perfume of the civet is so strong that it communicates itself to all parts of the animal's body, the fur is impregnated thereby and the skin penetrated to such a degree that it continues to preserve the odour for a long time after it is stript off. If a person be shut up with one of them in a close room he cannot support the perfume which is so copiously diffused. When the animal is irritated as in all the wessel kind its scent is much more violent than ordinary and if it be tormented so as to make it sweat, this also is a strong perfume and serves to adulterate or increase what is otherwise obtained from it. In general it is sold in Holland for about fifty shillings an ounce although like all other commodities its value alters in proportion to the demand. Civet must be chosen new of a good consistence a whitish colour and a strong disagreeable smell. There is still a very considerable traffic carried on from Bussorah Calicut and other places in India where the animal that produces it is bred from the Levant also from Guinea and especially from Brasil in South America although Mr Buffon is of opinion that the animal is a native only of the Old Continent and not to be found wild in the New. The best civet however is furnished as was observed by the Dutch though not in such quantities at present as some years past when this perfume was more in fashion. Civet is a much more grateful perfume than musk to which it has some resemblance and was some years ago used for the same purposes in medicine. But at present it is quite discontinued in prescription and persons of taste or elegance seem to proscribe it even from the toilet. Perfumes like dress have their vicissitudes musk was in peculiar repute until displaced by civet both gave ground upon discovering the manner of preparing ambergrise and even this is now disused for the less powerful vegetable kinds of fragrance spirit of lavender or otto of roses.

As to the rest, the civet is said to be a wild fierce animal; and, although sometimes tamed, is never thoroughly familiar. Its teeth are strong and cutting, although its claws be feeble and flexible. It is light and active, and lives by prey, as the rest of its kind, pursuing birds, and other small animals that it is able to overcome. They are sometimes seen stealing into the yards and outhouses, to seize upon the poultry: their eyes shine in the night, and it is very probable that they see better in the dark than by day. When they fail of animal food, they are found to subsist upon roots and fruits, and very seldom drink, for which reason they are never found near great waters. They breed very fast in their native climates, where the heat seems to conduce to their propagation; but in our temperate latitudes, although they furnish their perfume in great quantities, yet they are not found to multiply. A proof that their perfume has no analogy with their appetite for generation.

THE GLUTTON.*

I WILL add but one animal more to this numerous class of the weasel kind, namely, the glutton; which, for several reasons, seems to belong to this tribe, and this only. We have hitherto had no precise description of this quadruped; some resembling it to a badger, some to a fox, and some to a hyæna. Linnæus places it among the weasels, from the similitude of its teeth; it should seem to me to resemble this animal still more, from the great length of its body, and the shortness of its legs, from the softness of its fur, its disagreeable scent, and its insatiable appetite for animal food. Mr. Klein, who saw one of them, which was brought alive from Siberia, assures us, that it was about three feet long,† and about a foot and a half high.

* This animal is now ascertained to be a species of bear. It is about three feet long, besides the tail, which is a foot in length. Its size is equal to that of the common fox, though, like others of its tribe, it is of a more clumsy make, and its back is more convex. Its general colour is a blackish brown, with the sides paler. The variety called the Wolverine is distinguished by its superior size, in the colour of its body, which is dull ferruginous, with the front, throat, and longitudinal stripe on the body, whitish.

† He says, it was an ell and eight inches long. I have, therefore, given its length, as supposing it to be a Flemish ell, which is 27 inches.

If we compare these dimensions with those of other animals we shall find that they approach more nearly to the class we are at present describing than any other, and that the glutton may very justly be conceived under the form of a great overgrown weasel. Its nose its ears its teeth and its long bushy tail are entirely similar and as to what is said of its being rather corpulent than slender it is most probable that those who described it thus saw it after eating at which time its belly we are assured is most monstrously distended however suspending all certainty upon this subject I will take leave rather to follow Linnæus than Buffon in describing this animal and leave future experience to judge between them.

The glutton which is so called from its voracious appetite is an animal found as well in the north of Europe and Siberia as in the northern parts of America where it has the name of the *carcajou*. Amidst the variety of descriptions which have been given of it no very just idea can be formed of its figure, and indeed some naturalists among whom was Ray entirely doubted of its existence. From the best accounts however we have of it the body is thick and long the legs short it is black along the back and of a reddish brown on the sides its fur is held in the highest estimation for its softness and beautiful gloss the tail is bushy like that of the weasel but rather shorter, and its legs and claws are better fitted for climbing trees than for running along the ground. Thus far it entirely resembles the weasel and its manner of taking its prey is also by surprise and not by pursuit.

Scarcely any of the animals with short legs and long bodies pursue their prey but knowing their own incapacity to overtake it by swiftness either creep upon it in its retreats or wait in ambush and seize it with a bound. The glutton from the make of its legs and the length of its body must be particularly slow and consequently its only resource is in taking its prey by surprise. All the rest of the weasel kind from the smallness of their size are better fitted for a life of insidious rapine than this they can pursue their prey into its retreats they can lurk unseen among the branches of trees and hide themselves with ease under the leaves but the glutton is too large to follow small prey into their retreats, nor would such even

if obtained, be sufficient to sustain it For these reasons, therefore, this animal seems naturally compelled to the life for which it has long been remarkable Its only resource is to climb a tree, which it does with great ease, and there it waits with patience until some large animal passes underneath, upon which it darts down with unerring certainty, and destroys it

It is chiefly in North America that this voracious creature is seen lurking among the thick branches of trees, in order to surprise the deer, with which the extensive forests of that part of the world abound Endued with a degree of patience equal to its rapacity, the glutton singles out such trees as it observes marked by the teeth or the antlers of the deer; and is known to remain there watching for several days together If it has fixed upon a wrong tree, and finds that the deer have either left that part of the country, or cautiously shun the place, it reluctantly descends, pursues the beaver to its retreat, or even ventures into the water in pursuit of fishes But if it happens that, by long attention and keeping close, at last the elk or the rein-deer happen to pass that way, it at once darts down upon them, sticks its claws between their shoulders, and remains there unalterably firm It is in vain that the large flighted animal increases its speed, or threatens with its branching horns, the glutton having taken possession of its post, nothing can drive it off, its enormous prey dives rapidly along amongst the thickest woods, rubs itself against the largest trees, and tears down the branches with its expanded horns; but still its insatiable foe sticks behind, eating its neck, and digging its passage to the great blood-vessels that lie in that part Travellers who wander through those deserts, often see pieces of the glutton's skin sticking to the trees, against which it was rubbed by the deer But the animal's voracity is greater than its feelings, and it never seizes without bringing down its prey When, therefore, the deer, wounded and feeble with the loss of blood, falls, the glutton is seen to make up for its former abstinence by its present voracity As it is not possessed of a feast of this kind every day, it resolves to lay in a store to serve it for a good while to come. It is, indeed, amazing how much one of these animals can eat at a time! That which was seen by Mr Klein, although without exercise or an,

although taken from its native climate and enjoying but an indifferent state of health was yet seen to eat thirteen pounds of flesh every day and yet remain unsatisfied. We may therefore easily conceive how much more it must devour at once after a long fast of a food of its own procuring and in the climate most natural to its constitution. We are told accordingly that from being a lank thin animal which it naturally is it then gorges in such quantities that its belly is distended and its whole figure seems to alter. Thus voraciously it continues eating till incapable of any other animal function it lies totally torpid by the animal it has killed and in this situation continues for two or three days. In this loathsome and helpless state it finds its chief protection from its horrid smell which few animals care to come near * so that it continues eating and sleeping till its prey be devoured bones and all and then it mounts a tree in quest of another adventure.

The glutton like many others of the weasel kind seems to prefer the most putrid flesh to that newly killed and such is the voraciousness of this hateful creature that if its swiftness and strength were equal to its rapacity it would soon thin the forest of every other living creature. But fortunately it is so slow that there is scarcely a quadruped that cannot escape it except the beaver. Thus therefore it very frequently pursues upon land but the beaver generally makes good its retreat by taking to the water where the glutton has no chance to succeed. This pursuit only happens in summer for in the winter all that remains is to attack the beaver's house as at that time it never stirs from home. This attack however seldom succeeds for the beaver has a covert way bored under the ice and the glutton has only the trouble and disappointment of sacking an empty town.

A life of necessity generally produces a good fertile invention. The glutton continually pressed by the call of appetite and having neither swiftness nor activity to satisfy it is obliged to make up by stratagem the defects of nature. It is often seen to examine the traps and the snares laid for other animals in order to anticipate the fowlers. It is said to practise a thousand arts to procure its prey to steal upon the retreats of the rein deer the flesh of which animal it loves in preference to all others to lie in wait

for such animals as have been maimed by the hunters; to pursue the isatis while it is hunting for itself; and when that animal has run down its prey, to come in and seize upon the whole, and sometimes to devour even its poor provider; and when these pursuits fail, even to dig up the graves, and fall upon the bodies interred there, devouring them, bones and all. For these reasons, the natives of the countries where the glutton inhabits, hold it in utter detestation, and usually term it the vulture of quadrupeds. And yet it is extraordinary enough, that, being so very obnoxious to man, it does not seem to fear him *. We are told by Gmelin of one of these coming up boldly and calmly where there were several persons at work, without testifying the smallest apprehension, or attempting to run, until it had received several blows, that at last totally disabled it. In all probability it came among them seeking its prey; and, having been used to attack animals of inferior strength, it had no idea of a force superior to its own. The glutton, like all the rest of its kind, is a solitary animal; and is never seen in company except with its female, with which it couples in the midst of winter. The latter goes with young about four months, and brings forth two or three at a time †. They burrow in holes as the weasel, and the male and female are generally found together, both equally resolute in defence of their young. Upon this occasion the boldest dogs are afraid to approach them; they fight obstinately, and bite most cruelly. However, as they are unable to escape by flight, the hunters come to the assistance of the dogs, and easily overpower them. Their flesh, it may readily be supposed, is not fit to be eaten, but the skins amply recompense the hunters for their toil and danger. The fur has the most beautiful lustre that can be imagined, and is preferred before all others, except that of the Siberian fox, or the sable. Among other peculiarities of this animal, Linnæus informs us, that it is very difficult to be skinned, but from what cause, whether its abominable stench, or the skin's tenacity to the flesh, he has not thought fit to inform us.

* Buffon

† Linnæi Systema, p 67

BOOK V

*ANIMALS OF THE HARE KIND**

INTRODUCTION

HAVING described in the last chapter a tribe of minute fierce rapacious animals I come now to a race of minute animals of a more harmless and gentle kind that without being enemies to any are preyed upon by all. As Nature has fitted the former for hostility so it has entirely formed the latter for evasion and as the one kind subsist by their courage and activity so the other find safety from their swiftness and their fears. The hare is the swiftest animal in the world for the time it continues and few quadrupeds can overtake even the rabbit when it has but a short way to run. To this class also we may add the squirrel somewhat resembling the hare and rabbit in its form and nature and equally pretty inoffensive and pleasing.

If we were methodically to distinguish animals of the hare kind from all others we might say that they have but two cutting teeth above and two below that they are covered with a soft downy fur and that they have a bushy tail. The combination of these marks might perhaps distinguish them tolerably well, whether from the rat the beaver the otter or any other most nearly approaching in form. But as I have declined all method that rather tends to embarrass history than enlighten it I am contented to class these animals together for no very precise reason but because I find a general resemblance between them in their natural habits and in the shape of their heads and body. I call a squirrel an animal of the hare kind because it is something like a hare. I call the paca of the same kind merely because it is more like a rabbit than any other animal I know of. In short it is fit to erect some particular

* The animals of this family have two front teeth in each jaw those in the upper jaw are doubled having two smaller ones standing behind the others they feed entirely on vegetables are very small and run by a kind of leaping they have five toes on the fore feet and four on the hinder

standard in the imagination of the reader, to refer him to some animal that he knows, in order to direct him in conceiving the figure of such as he does not know. Still, however, he should be apprised that his knowledge will be defective without an examination of each particular species; and that saying an animal is of this or that particular kind, is but a very trifling part of its history.

Animals of the hare kind, like all others that feed entirely upon vegetables, are inoffensive and timorous. As Nature furnishes them with a most abundant supply, they have not that rapacity after food remarkable in such as are often stinted in their provision. They are extremely active and amazingly swift, to which they chiefly owe their protection; for being the prey of every voracious animal, they are incessantly pursued. The hare, the rabbit, and the squirrel, are placed by Pyerius, in his Treatise of Ruminating Animals, among the number of those that chew the cud; but how far this may be true I will not pretend to determine. Certain it is that their lips continually move whether sleeping or waking. Nevertheless they chew their meat very much before they swallow it, and for that reason I should suppose that it does not want a second mastication. All these animals use their fore-paws like hands, they are remarkably salacious, and are furnished by Nature with more ample powers than most others for the business of propagation. They are so very prolific, that were they not thinned by the constant depredations made upon them by most other animals, they would quickly over-run the earth.

THE HARE.

Of all these the hare is the largest, the most persecuted, and the most timorous; all its muscles are formed for swiftness; and all its senses seem only given to direct its flight. It has very large prominent eyes, placed backwards in its head, so that it can almost see behind it as it runs. These are never wholly closed, but as the animal is continually upon the watch, it sleeps with them open. The ears are still more remarkable for their size, they are moveable, and capable of being directed to every quarter; so that the smallest sounds are readily received, and the animal's

motions directed accordingly The muscles of the body are very strong and without fat so that it may be said to carry no superfluous burden of flesh about it the hinder feet are longer than the fore which still adds to the rapidity of its motions and almost all animals that are remarkable for their speed except the horse are formed in the same manner

An animal so well formed for a life of escape might be supposed to enjoy a state of tolerable security but as every rapacious creature is its enemy it but very seldom lives out its natural term Dogs of all kinds pursue it by instinct and follow the hare more eagerly than any other animal The cat and the weasel kinds are continually lying in ambush and practising all their little arts to seize it birds of prey are still more dangerous enemies as against them no swiftness can avail nor retreat secure but man an enemy far more powerful than all prefers its flesh to that of other animals and destroys greater numbers than all the rest Thus pursued and persecuted on every side the race would long since have been totally extirpated did it not find a resource in its amazing fertility

The hare multiplies exceedingly it is in a state of engendering at a few months old the female goes with young but thirty days and generally brings forth three or four at a time * As soon as they have produced their young they are again ready for conception and thus do not lose any time in continuing the breed But they are in another respect fitted in an extraordinary manner for multiplying their kind for the female from the conformation of her womb is often seen to bring forth and yet to continue pregnant at the same time or in other words to have young ones of different ages in her womb together Other animals never receive the male when pregnant but bring forth their young at once But it is frequently different with the hare the female often though already impregnated admitting the male and thus receiving a second impregnation The reason of this extraordinary circumstance is that the womb in these animals is divided in such a manner that it may be considered as a double organ one side of which may be filled while the other remains empty Thus these animals may be seen to couple at

* Buffon vol xiii p 12

every period of their pregnancy, and even while they are bringing forth young, laying the foundation of another brood

The young of these animals are brought forth with their eyes open, and the dam suckles them for twenty days, after which they leave her, and seek out for themselves * From this we observe, that the education these animals receive is but trifling, and the family connection but of a short duration In the rapacious kinds the dam leads her young forth for months together ; teaches them the arts of rapine, and, although she wants milk to supply them, yet keeps them under her care until they are able to hunt for themselves But a long connection of this kind would be very unnecessary as well as dangerous to the timid animals we are describing ; their food is easily procured, and their associations, instead of protection, would only expose them to their pursuers They seldom, however, separate far from each other, or from the place where they were produced ; but make each a form at some distance, having a predilection rather for the place than each other's society. They feed during the night rather than by day, choosing the more tender blades of grass, and quenching their thirst with the dew. They live also upon roots, leaves, fruits, and corn, and prefer such plants as are furnished with a milky juice They also strip the bark of trees during the winter, there being scarcely any that they will not feed on, except the lime or the alder. They are particularly fond of birch, pinks, and parsley When they are kept tame, they are fed with lettuce and other garden herbs, but the flesh of such as are thus brought up is always indifferent.

They sleep or repose in their forms by day, and may be said to live only by night † It is then that they go forth to feed and couple They do not pair, however, but in the rutting season, which begins in February, the male pursues and discovers the female by the sagacity of its nose They are then seen by moonlight, playing, skipping, and pursuing each other, but the least motion, the slightest breeze, the falling of a leaf, is sufficient to disturb their revels, they instantly fly off, and each takes a separate way.

* Buffon, vol xiii p 12

† Ibid

As their limbs are made for running they easily outstrip all other animals in the beginning and could they preserve their speed it would be impossible to overtake them but as they exhaust their strength at their first efforts and double back to the place they were started from they are more easily taken than the fox which is a much slower animal than they As their hind legs are longer than the fore they always choose to run up hill by which the speed of their pursuers is diminished while theirs remains the same Their motions are also without any noise as they have the sole of the foot furnished with hair and they seem the only animals that have hair on the inside of their mouths

They seldom live above seven or eight years at the utmost they come to their full perfection in a year and thus multiplied by seven as in other animals gives the extent of their lives * It is said however that the females live longer than the males of this Mr Buffon makes a doubt but I am assured that it is so They pass their lives in our climate in solitude and silence and they seldom are heard to cry except when they are seized or wounded Their voice is not so sharp as the note of some other animals but more nearly approaching that of the squalling of a child They are not so wild as their dispositions and their habits seem to indicate but are of a complying nature and easily susceptible of a kind of education They are easily tamed They even become fond and caressing but they are incapable of attachment to any particular person and never can be depended upon for though taken never so young they regain their native freedom at the first opportunity As they have a remarkably good ear and sit upon their hind legs and use their fore paws as hands they have been taught to beat the drum to dance to music and go through the manual exercise

But their natural instincts for their preservation are much more extraordinary than those artificial tricks that are taught them They make themselves a form particularly in those places where the colour of the grass most resembles that of their skin it is open to the south in winter and to the north in summer The hare when it hears the hounds at a distance flies for some time through a natural impulse

* Buffon vol xiii p 12

without managing its strength, or consulting any other means but speed for its safety. Having attained some hill or rising ground, and left the dogs so far behind that it no longer hears their cries, it stops, rears on its hinder legs, and at length looks back to see if it has not lost its pursuers. But these, having once fallen upon the scent, pursue slowly and with united skill, and the poor animal soon again hears the fatal tidings of their approach. Sometimes when sore hunted it will start a fresh hare, and squat in the same form; sometimes it will creep under the door of a sheep-cot, and hide among the sheep, sometimes it will run among them, and no vigilance can drive it from the flock, some will enter holes like the rabbit, which the hunters call going to *vault*, some will go up one side of the hedge and come down the other; and it has been known that a hare sorely hunted has got upon the top of a quick-set hedge, and run a good way thereon, by which it has effectually evaded the hounds. It is no unusual thing also for them to betake themselves to furze bushes, and to leap from one to another, by which the dogs are frequently misled. However, the first doubling a hare makes is generally a key to all its future attempts of that kind, the latter being exactly like the former. The young hares tread heavier, and leave a stronger scent than the old, because their limbs are weaker, and the more this forlorn creature tines, the heavier it treads, and the stronger is the scent it leaves. A buck, or male hare, is known by its choosing to run upon hard highways, feeding farther from the wood-sides, and making its doubling of a greater compass than the female. The male having made a turn or two about its form, frequently leads the hounds five or six miles on a stretch; but the female keeps close by some covert side, turns, crosses, and winds among the bushes like a rabbit, and seldom runs directly forward. In general, however, both male and female regulate their conduct according to the weather. In a moist day they hold by the highways more than at any other time, because the scent is then strongest upon the grass. If they come to the side of a grove or spring, they forbear to enter, but squat down by the side thereof until the hounds have overshot them, and then, turning along their former path, make to their old form, from which they vainly hope for protection.

Hares are divided by the hunters into mountain and meased hares. The former are more swift vigorous and have the flesh better tasted, the latter chiefly frequent the marshes when hunted keep among low grounds and their flesh is moist white and flabby. When the male and female keep one particular spot they will not suffer any strange hare to make its form in the same quarter, so that it is usually said that the more you hunt the more hares you shall have for having killed one hare others come and take possession of its form. Many of these animals are found to live in woods and thickets but they are naturally fonder of the open country and are constrained only by fear to take shelter in places that afford them neither a warm sun nor an agreeable pasture. They are, therefore usually seen stealing out of the hedges of the wood to taste the grass that grows shorter and sweeter in the open fields than under the shade of the trees however they seldom miss of being pursued and every excursion is a new adventure. They are shot at by porchers, traced by their footsteps in the snow caught in springs dogs birds and cats are all combined against them ants snakes and adders drive them from their forms especially in summer even fleas from which most other animals are free persecute this poor creature and so various are its enemies that it is seldom permitted to reach even that short term to which it is limited by nature.

The soil and climate have their influence upon this animal as well as on most others. In the countries bordering on the north pole, they become white in winter and are often seen in great troops of four or five hundred running along the banks of the river Irtysh or the Jenisca and are as white as the snow they tread on. They are caught in traps for the sake of their skins which on the spot are sold for less than seven shillings a hundred. Their fur is well known to form a considerable article in the hat manufacture and we accordingly import vast quantities of it from those countries where the hare abounds in such plenty. They are found also entirely black but these in much less quantities than the former * and even some have been seen with horns though these but rarely †

* Klein Disp. Quadrup. p. 59

† Johnston de Quadrup. l. ii. c. 2

The hares of the hot countries, particularly in Italy, Spain, and Barbary, are smaller than ours those bred in the Milanese country are said to be the best in Europe * There is scarcely a country where this animal is not to be found, from the torrid zone to the neighbourhood of the polar circle The natives of Guinea knock them on the head as they come down to the sides of the rivers to drink. They also surround the place where they are seen in numbers, and clattering a short stick, which every man carries, against that which the person next him carries, they diminish their circle gradually, till the hares are cooped up in the midst They then altogether throw their sticks in among them, and with such deadly force, that they seldom fail of killing great numbers at a time †

The flesh of this animal has been esteemed a delicacy among some nations, and it is held in detestation by others. The Jews, the ancient Britons, and the Mahometans, all considered it as an unclean animal, and religiously abstained from it On the contrary, there are scarce any other people, however barbarous at present, that do not consider it as the most agreeable food Fashion seems to preside and govern all the senses; what mankind at one time consider as beautiful, fragrant, or savoury, may at another time, or among other nations, be regarded as deformed, disgusting, or ill-tasted. That flesh which the ancient Romans so much admired as to call it the food of the wise, was, among the Jews and the Druids, thought unfit to be eaten; and even the moderns, who, like the Romans, consider the flesh of this animal as a delicacy, have very different ideas as to dressing it With us it is simply served up without much seasoning but Apicius shews us the manner of dressing a hare in true Roman taste, with parsley, rice, vinegar, cummin seed, and coriander.‡

THE RABBIT

THE hare and the rabbit, though so very nearly resembling each other in form and disposition, are yet distinct kinds, as they refuse to mix with each other. Mr. Buffon

* Dictionnaire Raisonné L'œuvre

† Hist Gen des Voyages, tom iv p 171

‡ Vid Apiciu, &c.

bred up several of both kinds in the same place but from being at first indifferent they soon became enemies, and their combats were generally continued until one of them was disabled or destroyed. However though these experiments were not attended with success I am assured that nothing is more frequent than an animal bred between these two but which like the mule is marked with sterility. Nay it has been actually known that the rabbit couples with animals of a much more distant nature and there is at present in the Museum at Brussels a creature covered with feathers and hair and said to be bred between a rabbit and a hen. The fecundity of the rabbit is still greater than that of the hare and if we should calculate the produce from a single pair in one year the number would be amazing. They breed seven times in a year and bring eight young ones each time. On a supposition therefore that this happens regularly at the end of four years a couple of rabbits shall see a progeny of almost a million and half. From hence we must justly apprehend being overstocked by their increase but happily for mankind their enemies are numerous and their nature inoffensive so that their destruction bears a near proportion to their fertility.

But although their numbers be diminished by every beast and bird of prey and still more by man himself yet there is no danger of their extirpation. The hare is a poor defenceless animal that has nothing but its swiftness to depend on for safety its numbers are therefore every day decreasing and in countries that are well peopled the species are so much kept under that laws are made for their preservation. Still however it is most likely that they will be at last totally destroyed and like the wolf or the elk in some countries be only kept in remembrance. But it is otherwise with the rabbit its fecundity being greater and its means of safety more certain. The hare seems to have more various arts and instincts to escape its pursuers by doubling squatting and winding the rabbit has but one art of defence alone but in that one finds safety by making itself a hole where it continues a great part of the day and breeds up its young there it continues secure from the fox the hound the kite and every other enemy.

Nevertheless, though this retreat be safe and convenient, the rabbit does not seem to be naturally fond of keeping there. It loves the sunny field and the open pasture, it seems to be a chilly animal, and dislikes the coldness of its under-ground habitation. It is, therefore, continually out, when it does not fear disturbance; and the female often brings forth her young at a distance from the warren, in a hole, not above a foot deep at the most. There she suckles them for about a month, covering them over with moss and grass, whenever she goes to pasture, and scratching them up at her return. It has been said, indeed, that this shallow hole without the warren is made lest the male should attack and destroy her young; but I have seen the male himself attend the young there, lead them out to feed, and conduct them back upon the return of the dam. This external retreat seems a kind of country house, at a distance from the general habitation; it is usually made near some spot of excellent pasture, or in the midst of a field of sprouting corn. To this both male and female often retire from the warren, lead their young by night to the food which lies so convenient, and, if not disturbed, continue there till they are grown up. There they find a greater variety of pasture than near the warren, which is generally eaten bare; and enjoy a warmer sun, by covering themselves up in a shallower hole. Whenever they are disturbed, they then forsake their retreat of pleasure for one of safety, they fly to the warren with their utmost speed, and if the way be short, there is scarcely any dog, how swift soever, that can overtake them.

But it does not always happen that these animals are possessed of one of these external apartments, they most usually bring forth their young in the warren, but always in a hole, separate from the male. On these occasions, the female digs herself a hole,* different from the ordinary one, by being more intricate; at the bottom of which she makes a more ample apartment. This done, she pulls off from her belly a good quantity of her hair, with which she makes a kind of bed for her young. During the two first days she never leaves them; and does not stir out but to procure nourishment, which she takes with the utmost

* Buffon

dispatch in this manner suckling her young for near six weeks until they are strong and able to go abroad themselves. During all this time the male seldom visits their separate apartments but when they are grown up so as to come to the mouth of the hole, he then seems to acknowledge them as his offspring takes them between his paws smooths their skin and licks their eyes all of them one after the other have an equal share in his carresses.

In this manner the rabbit when wild consults its pleasure and its safety but those that are bred up tame do not take the trouble of digging a hole conscious of being already protected. It has also been observed * that when people to make a warren stock it with tame rabbits these animals having been unaccustomed to the art of scraping a hole continue exposed to the weather and every other accident without ever burrowing. Their immediate offspring also are equally regardless of their safety and it is not till after two or three generations that these animals begin to find the necessity and convenience of an asylum and practise an art which they could only learn from nature.

Rabbits of the domestic breed like all other animals that are under the protection of man are of various colours white brown black and mouse colour. The black are the most scarce the brown white and mouse colour, are in greater plenty. Most of the wild rabbits are of a brown and it is the colour which prevails among the species for in every nest of rabbits whether the parents be black or white there are some brown ones found of the number. But in England there are many warrens stocked with the mouse colour kinds which some say came originally from an island in the river Humber and which still continue their original colour after a great number of successive generations. A gentleman † who bred up tame rabbits for his amusement gives the following account of their production. I began says he by having but one male and female only the male was entirely white and the female brown but in their posterity the number of the brown by far exceeded those of any other colour there were some

* Buffon

† Mr Moutier as quoted by Mr Buffon

white, some party-coloured, and some black. It is surprising how much the descendants were obedient and submissive to their common parent; he was easily distinguished from the rest by his superior whiteness, and, however numerous the other males were, this kept them all in subjection. Whenever they quarrelled among each other, either for their females or provisions, as soon as he heard the noise, he ran up to them with all dispatch, and, upon his appearance, all was instantly reduced to peace and order. If he caught any of them in the fact, he instantly punished them, as an example to the rest. Another instance of his superiority was, that having accustomed them to come to me with the call of a whistle, the instant this signal was given I saw him marshalling them up, leading them the foremost, and then suffering them all to file off before him."

The rabbit,* though less than the hare, generally lives longer. As these animals pass the greater part of their lives in their burrow, where they continue at ease and unmolested, they have nothing to prevent the regularity of their health, or the due course of their nourishment. They are, therefore, generally found fatter than the hare, but their flesh is, notwithstanding, much less delicate. That of the old ones, in particular, is hard, tough, and dry; but it is said, that in warmer countries they are better tasted. This may very well be, as the rabbit, though so very plentiful in Great Britain and Ireland, is nevertheless a native of the warmer climates, and has been originally imported into these kingdoms from Spain. In that country, and in some of the islands in the Mediterranean, we are told that they once multiplied in such numbers as to prove the greatest nuisance to the natives. They at first demanded military aid to destroy them, but soon after they called in the assistance of ferrets, which originally came from Africa, and these, with much more ease and expedition, contrived to lessen the calamity. In fact, rabbits are found to love a warm climate, and to be incapable of bearing the cold of the north, so that in Sweden they are obliged to be littered in the houses. It is otherwise in all the tropical climates, where they are extremely common, and where they seldom burrow, as with us. The

* Mr Moutier, as quoted by Mr Buffon

English counties that are most noted for these animals are Lincolnshire Norfolk, and Cambridgeshire They delight in grounds of a sandy soil which are warmer than those of clay, and which also furnish a softer and finer pasture

The tame rabbits are larger than the wild ones from their taking more nourishment and using less exercise but their flesh is not so good being more insipid and softer In order to improve it they are chiefly fed upon bran and are stinted in their water for if indulged in too great plenty of moist food they are apt as the feeders express it, to grow rotten The hair or fur is a very useful commodity and is employed in England for several purposes as well when the skin is dressed with it on as when it is pulled off The skins especially the white are used for lining clothes and are considered as a cheap imitation of ermine The skin of the male is usually preferred as being the most lasting but it is coarser than on the belly in either sex is the best and finest But the chief use made of rabbits fur is in the manufacture of hats it is always mixed in certain proportions with the fur of the beaver and it is said to give the latter more strength and consistence

The Syrian rabbit like all other animals bred in that country is remarkable for the length of its hair it falls along the sides in wavy wreaths and is in some places curled at the end like wool it is shed once a year in large masses and it often happens that the rabbit dragging a part of its robe on the ground appears as if it had got another leg or a longer tail There are no rabbits naturally in America however those that have been carried from Europe are found to multiply in the West India islands in great abundance In other parts of that continent they have animals that in some measure resemble the rabbits of Europe and which most European travellers have often called *hares* or *rabbits* as they happened to be large or small Their giving them even the name will be a sufficient excuse for my placing them among animals of the hare kind although they may differ in many of the most essential particulars But before we go to the new continent we will first examine such as bear even a distant resemblance to the hare land at home

THE SQUIRREL *

THERE are few readers that are not so well acquainted with the figure of a Squirrel as that of the rabbit, but supposing it unknown to any, we might give them some idea of its form, by comparing it to a rabbit, with shorter ears, and a longer tail. The tail, indeed, is alone sufficient to distinguish it from all others, as it is extremely long, beautiful, and bushy, spreading like a fan, and which, when thrown up behind, covers the whole body. This serves the little animal for a double purpose, when erected, it serves, like an umbrella, as a secure protection from the injuries of the heat and cold, and when extended, it is very instrumental in promoting those vast leaps that the squirrel takes from tree to tree; nay, some assert that it answers still a third purpose, and when the squirrel takes the water, which it sometimes does upon a piece of bark, that its tail serves it instead of a sail †

There are few wild animals in which there are so many varieties as in the squirrel. The *common squirrel* is of the size of a small rabbit, and is rather of a more reddish brown. The belly and breast are white, and the ears beautifully ornamented with long tufts of hair, of a deeper colour than that on the body. The eyes are large, black, and lively, the legs are short and muscular, like those of the rabbit, but the toes longer, and the claws sharper, so as to fit it for climbing. When it eats, or dresses itself, it sits erect, like the hare or rabbit, making use of its fore-legs as hands; and chiefly resides in trees. The *gray Virginia squirrel*, which Mr. Buffon calls the *petit gris*, is larger than a rabbit, and of a grayish colour. Its body and limbs are thicker than those of the common squirrel, and its ears are shorter, and without tufts at the point. The upper part of the body, and external part of the legs, are of a fine whitish gray, with a beautiful red streak on each side lengthways. The tail is covered with very long gray hair, variegated with black and white towards the extremity. This variety seems to be common to both continents, and in

* This elegant tribe of quadrupeds have two front teeth in each jaw, those in the upper jaw being wedge-shaped, those in the lower pointed on each side in the upper jaw there are five grinders, and four in the lower they have perfect collar bones, and in most species the tail is shed on each side

† Klein Linnæus

Sweden is seen to change colour in winter. The *Barbary squirrel* of which Mr Buffon makes three varieties is of a mixed colour between red and black. Along the sides there are white and brown lines which render this animal very beautiful but what still adds to its elegance is that the belly is of a sky blue surrounded with white. Some of these hold up their tail erect and others throw it forward over their body. The *Siberian white squirrel* is of the size of a common squirrel. The *Carolina black squirrel* is much bigger than the former and sometimes tipped with white at all the extremities. The *Braslian squirrel* which Mr Buffon calls the *coquallin* is a beautiful animal of this kind and very remarkable for the variety of its colours. Its belly is of a bright yellow its head and body variegated with white black brown and orange colour. It wants the tufts at the extremity of its ears and does not climb trees as most of the kind are seen to do. To this list may be added the *little ground squirrel of Carolina* of a reddish colour and blackish stripes on each side and like the former not delighting in trees. Lastly the *squirrel of New Spain* which is of a deep iron gray colour with seven longitudinal whitish streaks along the sides of the male and five along those of the female. As for the flying squirrels they are a distinct kind and shall be treated of by themselves.

These which I suppose to be but a few of the numerous varieties of the squirrel sufficiently serve to shew how extensive this animal is diffused over all parts of the world. It is not to be supposed however that every variety is capable of sustaining every climate for few animals are so tender or so little able to endure a change of abode as this. Those bred in the tropical climates will only live near a warm sun while on the contrary the squirrel of Siberia will scarce endure the temperature of ours. These varieties do not only differ in their constitutions and colour but in their dispositions also for while some live on the tops of trees others feed like rabbits on vegetables below. Whether any of these so variously coloured and so differently disposed would breed among each other we can not tell and since therefore we are left in uncertainty upon this point we are at liberty either to consider each as a distinct species by itself, or only a variety that accident

might have originally produced, and that the climate or soil might have continued. For my own part, as the original character of the squirrel is so strongly marked upon them all, I cannot help considering them in the latter point of view, rather as the common descendants of one parent, than originally formed with such distinct similitudes

The squirrel is a beautiful little animal,^{*} which is but half savage, and which, from the gentleness and innocence of its manners, deserves our protection. It is neither carnivorous nor hurtful: its usual food is fruits, nuts, and acorns, it is cleanly, nimble, active, and industrious, its eyes are sparkling, and its physiognomy marked with meaning. It generally, like the hare and rabbit, sits up on its hinder legs, and uses the fore-paws as hands, these have five *claws* or *toes*, as they are called, and one of them is separated from the rest like a thumb. This animal seems to approach the nature of birds, from its lightness, and surprising agility on the tops of trees. It seldom descends to the ground, except in case of storms, but jumps from one branch to another, feeds, in spring, on the buds and young shoots, in summer, on the ripening fruits, and particularly the young cones of the pine-tree. In autumn it has an extensive variety to feast upon; the acorn, the filbert, the chesnut, and the wilding. This season of plenty, however, is not spent in idle enjoyment, the provident little animal gathers at that time its provisions for the winter, and cautiously foresees the season when the forest shall be stripped of its leaves and fruitage

Its nest is generally formed among the large branches of a great tree, where they begin to fork off into small ones. After choosing the place where the timber begins to decay, and an hollow may the more easily be formed, the squirrel begins by making a kind of level between the forks, and then bringing moss, twigs, and dry leaves, it binds them together with great art, so as to resist the most violent storm. This is covered up on all sides, and has but a single opening at top, which is just large enough to admit the little animal; and this opening is itself defended from the weather by a kind of canopy, made in the fashion of a cone, so that it throws off the rain, though never so heavy. The nest thus formed, with a very little opening above, is, nevertheless,

* Buffon

very commodious and roomy below, soft well knit together and every way convenient and warm. In this retreat the little animal brings forth its young shelters itself from the scorching heat of the sun which it seems to fear and from the storms and inclemency of winter which it is still less capable of supporting. Its provision of nuts and acorns is seldom in its nest but in the hollows of the tree laid up carefully together and never touched but in cases of necessity. Thus one single tree serves for a retreat and a storehouse and without leaving it during the winter the squirrel possesses all those enjoyments that its nature is capable of receiving. But it sometimes happens that its little mansion is attracted by a devilly and powerful foe. The martin goes of en in quest of a retreat for its young which it is incapable of making for itself for this reason it fixes upon the nest of a squirrel and with double injustice destroys the tenant and then takes possession of the mansion.

However this is a calamity that but seldom happens and of all other animals the squirrel leads the most frolick some playful life being surrounded with abundance and having few enemies to fear. They are in heat early in spring when as a modern naturalist says * it is very diverting to see the female eluding an escape from the pursuit of two or three males and to observe the various proofs which they give of their agility which is then exerted in full force. Nature seems to have been particular in her formation of these animals for propagation however they seldom bring forth above four or five young at a time and that but once a year. The time of their gestation seems to be about six weeks they are pregnant in the beginning of April and bring forth about the middle of May.

The squirrel is never found in the open fields nor yet in copses or underwoods it always keeps in the midst of the tallest trees and as much as possible shuns the habitations of men. It is extremely watchful if the tree in which it resides be but touched at the bottom the squirrel instantly takes the alarm quits its nest at once flies off to another tree and thus travels with great ease along the tops of the forest until it finds itself perfectly out of danger. In this manner it continues for some hours at a distance from

* British Zoology

home, until the alarm be past away, and then it returns, by paths that to all quadrupeds but itself are utterly impassable. Its usual way of moving is by bounds, these it takes from one tree to another, at forty feet distance; and if at any time it is obliged to descend, it runs up the side of the next tree with amazing facility. It has an extremely sharp piercing note, which most usually expresses pain; it has another, more like the purring of a cat, which it employs when pleased, at least it appeared so in that from whence I have taken a part of this description.

In Lapland, and the extensive forests to the north, the squirrels are observed to change their habitation, and to remove in vast numbers from one country to another. In these migrations they are generally seen by thousands, travelling directly forward, while neither rocks, forests, nor even the broadest waters, can stop their progress. What I am going to relate appears so extraordinary, that were it not attested by numbers of the most credible historians, among whom are Klein and Linnæus, it might be rejected, with that scorn with which we treat imposture or credulity. However, nothing can be more true than that when these animals, in their progress, meet with broad rivers, or extensive lakes, which abound in Lapland, they take a very extraordinary method of crossing them. Upon approaching the banks, and perceiving the breadth of the water, they return, as if by common consent, into the neighbouring forest, each in quest of a piece of bark, which answers all the purposes of boats for wafting them over. When the whole company are fitted in this manner, they boldly commit their little fleet to the waves, every squirrel sitting on its own piece of bark, and fanning the air with its tail, to drive the vessel to its desired port. In this orderly manner they set forward, and often cross lakes several miles broad. But it too often happens that the poor mariners are not aware of the dangers of their navigation; for although at the edge of the water it is generally calm, in the midst it is always more turbulent. There the slightest additional gust of wind oversets the little sailor and his vessel together. The whole navy, that but a few minutes before rode proudly and securely along, is now overturned, and a shipwreck of two or three thousand sail ensues. This, which is so unfortunate for the little

animal is generally the most lucky accident in the world for the Laplander on the shore who gathers up the dead bodies as they are thrown in by the waves eats the flesh and sells the skins for about a shilling the dozen *

The quirel is easily tamed and it is then a very familiar animal. It loves to lie warm and will often creep into a man's pocket or his bosom. It is usually kept in a box and fed with hazel nuts. Some find amusement in observing with what ease it bites the nut open and eats the kernel. In short it is a pleasing, pretty little domestic, and its tricks and habits may serve to entertain a mind unequal to stronger operations.

THE FLYING SQUIRREL

Mr. RAY was justly of opinion that the Flying Squirrel might more properly be said to be of the rat kind because its fur is shorter than in other quirels and its colours also more nearly approach the former. However as mankind have been content to class it among the squirrels it is scarcely worth making a new distinction in its favour. This little animal which is frequently brought over to England is less than a common squirrel and bigger than a field mouse. Its skin is very soft and elegantly adorned with a dark fur in some places and light gray in others. It has large prominent black and very sparkling eyes small ears and very sharp teeth with which it gnaws any thing quickly. When it does not leap its tail which is pretty enough lies close to its back but when it takes its spring the tail is moved backwards and forwards from side to side. It is said to partake somewhat of the nature of the squirrel of the rat and of the dormouse but that in which it is distinguished from all other animals is its peculiar conformation for taking those leaps that almost look like flying. It is indeed amazing to see it at one bound dart above a hundred yards from one tree to another. They are assisted in this spring by a very peculiar formation of the skin that extends from the fore feet to the hinder so that when the animal stretches its fore legs forward and its hind legs backward this skin is spread out between them somewhat like that between the legs of a bat. The surface of the body being thus increased

the little animal keeps buoyant in the air until the force of its first impulsion is expired, and then it descends. This skin, when the creature is at rest, or walking, continues wrinkled up on its sides, but when its limbs are extended, it forms a kind of web between them of above an inch broad on either side, and gives the whole body the appearance of a skin floating in the air. In this manner the flying squirrel changes place, not like a bird, by repeated strokes of its wings, but rather like a paper kite, supported by the expansion of the surface of its body, but with this difference, however, that, being naturally heavier than the air, instead of mounting it descends, and that jump, which upon the ground would not be above forty yards, when from a higher tree to a lower may be above a hundred.

This little animal is more common in America than in Europe, but not very commonly to be seen in either. It is usually found, like the squirrel, on the tops of trees, but, though better fitted for leaping, it is of a more torpid disposition, and is seldom seen to exert its powers, so that it is often seized by the polecat and the martin. It is easily tamed, but apt to break away whenever it finds an opportunity. It does not seem fond of nuts or almonds, like other squirrels, but is chiefly pleased with the sprouts of the birch, and the cones of the pine. It is fed in its tame state with bread and fruits, it generally sleeps by day, and is always most active by night. Some naturalists gravely caution us not to let it get among our corn fields, where, they tell us, it will do a great deal of damage, by cropping the corn as soon as it begins to ear!*

THE MARMOUT

FROM the description of the squirrel and its varieties, we proceed to a different tribe of animals, no way indeed resembling the squirrel, but still something like the rabbit and the hare. We are to keep these two animals still in view as the centre of our comparison, as objects to which many others may bear some similitude, though they but little

* He may easily be made tame, but he is apt to do a great deal of damage in the corn fields, because he will crop the corn as soon as it begins to ear

approach each other. Among the hare kind is the Marmout which naturalists have placed either among the hare kind or the rat kind as it suited their respective systems. In fact it bears no great resemblance to either but of the two it approaches much nearer the hare as well in the make of its head as in its size in its bushy tail and particularly in its chewing the cud which alone is sufficient to determine our choice in giving it its present situation. How it ever came to be degraded into the rat or mouse I cannot conceive for it no way resembles them in size being nearly as big as a hare or in its disposition since no animal is more tractable nor more easily tamed.

The marmout is as was said almost as big as a hare but it is more corpulent than a rat and has shorter legs. Its head pretty nearly resembles that of a hare except that its ears are much shorter. It is clothed all over with very long hair and a shorter fur below. These are of different colours black and gray. The length of the hair gives the body the appearance of greater corpulence than it really has and at the same time shortens the feet so that its belly seems touching the ground. Its tail is tufted and well furnished with hair and it is carried in a straight direction with its body. It has five claws behind and only four before. Thus it uses as the squirrel does to carry its food to its mouth and it usually sits upon its hinder parts to feed in the manner of that little animal.

The marmout is chiefly a native of the Alps and when taken young is tamed more easily than any other wild animal and almost as perfectly as any of those that are domestic*. It is readily taught to dance to wield a cudgel and to obey the voice of its master. Like the cat it has an antipathy to the dog and when it becomes familiar to the family and is sure of being supported by its master it attacks and bites even the largest mastiff. From its squat muscular make it has great strength joined to great agility. It has four large cutting teeth like all those of the hare kind but it uses them to much more advantage since in this animal they are very formidable weapons of defence. However it is in general a very inoffensive animal and except its enmity to dogs seems to live in friendship with

* Buffon from whence the remainder of this description is taken
N B He takes it from Gesner vol xvii

every creature, unless when provoked. If not prevented, it is very apt to gnaw the furniture of a house, and even to make holes through wooden partitions; from whence, perhaps, it has been compared to the rat. As its legs are very short, and made somewhat like those of a bear, it is often seen sitting up, and even walking on its hind-legs in like manner; but with the fore-paws, as was said, it uses to feed itself in the manner of a squirrel. Like all of the hare kind, it runs much swifter up hill than down; it climbs trees with great ease, and runs up the clefts of rocks or the contiguous walls of houses with great facility. It is ludicrously said that the Savoyards, who are the only chimney-sweepers of Paris, have learned this art from the marmout, which is bred in the same country.

These animals eat indiscriminately of whatever is presented to them, flesh, bread, fruits, herbs, roots, pulse, and insects. But they are particularly fond of milk, and butter. Although less inclined to petty thefts than the cat, yet they always try to steal into the dairy, where they lap up the milk like a cat, purring all the while like that animal, as an expression of their being pleased. As to the rest, milk is the only liquor they like. They seldom drink water, and refuse wine. When pleased or caressed, they often yelp like puppies; but when irritated or frightened, they have a piercing note that hurts the ear. They are very cleanly animals, and like the cat retire upon necessary occasions, but then bodies have a disagreeable scent, particularly in the heat of summer. This tinctures their flesh, which, being very fat and firm, would be very good, were not this flavour always found to predominate.

We have hitherto been describing affections in this animal which it has in common with many others, but we now come to one which particularly distinguishes it from all others of this kind, and indeed from every other quadruped, except the bat and the dormouse; this is its sleeping during the winter. The marmout, though a native of the highest mountains, and where the snow is never wholly melted, nevertheless seems to feel the influence of the cold more than any other, and in a manner has all its faculties chilled up in winter. This extraordinary suspension of life and motion for more than half the year, deserves our wonder, and excites our attention to consider the manner of such

temporary death and the subsequent revival But first to describe before we attempt to discuss

The marmout usually at the end of September or the beginning of October prepares to fit up its habitation for the winter from which it is never seen to issue till about the beginning or the middle of April This animal's little retreat is made with great precaution and fitted up with art It is a hole on the side of a mountain extremely deep with a spacious apartment at the bottom which is rather longer than it is broad In this several marmouts can reside at the same time without crowding each other or injuring the air they breathe The feet and claws of this animal seem made for digging and in fact they burrow into the ground with amazing facility scraping up the earth like a rabbit and throwing back what they have thus loosened behind them But the form of their hole is still more wonderful it resembles the letter Y the two branches being two openings which conduct into one channel which terminates in their general apartment that lies at the bottom As the hole is made on the declivity of a mountain there is no part of it on a level but the apartment at the end One of the branches or openings issues out sloping downwards and this serves as a kind of sink or drain to the whole family where they make their excrements and where the moisture of the place is drawn away The other branch on the contrary slopes upwards and this serves as their door upon which to go out and in The apartment at the end is very warmly stuccoed round with moss and hay of both which they make an ample provision during the summer As this is a work of great labour so it is undertaken in common some cut the finest grass others gather it and others take their turns to drag it into their hole Upon this occasion as we are told one of them lies on its back permits the hay to be heaped upon its belly keeps its paws upright to make greater room and in this manner lying still upon its back it is dragged by the tail hay and all to their common retreat This also some give as a reason for the hair being generally worn away on their backs as is usually the case, however a better reason for this may be assigned from their continually rooting up holes and passing through narrow openings But be this as it will certain it

is that they all live together, and work in common to make their habitation as snug and convenient as possible. In it they pass three parts of their lives, into it they retire when the storm is high, in it they continue while it rains; there they remain when apprehensive of danger, and never stir out except in fine weather, never going far from home even then. Whenever they venture abroad, one is placed as a sentinel, sitting upon a lofty rock, while the rest amuse themselves in playing along the green fields, or are employed in cutting grass and making hay for their winter's convenience. Then trusty sentinel, when an enemy, a man, a dog, or a bud of prey, approaches, apprises its companions with a whistle, upon which they all make home, the sentinel himself bringing up the rear.

But it must not be supposed that this hay is designed for provision, on the contrary, it is always found in as great plenty in their holes at the end as at the beginning of winter; it is only sought for the convenience of their lodging, and the advantages of their young. As to provision, they seem kindly apprised by Nature that during the winter, they shall not want any; so that they make no preparations for food, though so diligently employed in fitting up their abode. As soon as they perceive the first approaches of the winter, during which their vital motions are to continue in some measure suspended, they labour very diligently to close up the two entrances of their habitation, which they effect with such solidity, that it is easier to dig up the earth any where else than where they have closed it. At that time they are very fat, and some of them are found to weigh above twenty pounds, they continue so for even three months more, but by degrees their flesh begins to waste, and they are usually very lean by the end of winter. When their retreat is opened, the whole family is then discovered, each rolled into a ball, and covered up under the hay. In this state they seem entirely lifeless, they may be taken away, and even killed without their testifying any great pain; and those who find them in this manner, carry them home, in order to breed up the young and eat the old ones. A gradual and gentle warmth revives them, but they would die if too suddenly brought near the fire, or if their juices were too quickly liquefied.

Strictly speaking, says Mr. Buffon, these animals cannot

be said to sleep during the winter it may be called rather a *torpor* a stagnation of all the faculties * This torpor is produced by the congelation of their blood which is naturally much colder than that of all other quadrupeds The usual heat of man and other animals is about thirty degrees above congelation the heat of these is not above ten degrees Their internal heat is seldom greater than that of the temperature of the air This has been often tried by plunging the ball of the thermometer into the body of a living dormouse and it never rose beyond its usual pitch in air and sometimes it sunk above a degree It is not surprising therefore that these animals whose blood is so naturally should become torpid when the external cold is too powerful for the small quantity of heat in their bodies yet remaining and this always happens when the thermometer is not more than ten degrees above congelation This coldness Mr Buffon has experienced in the blood of the bat the dormouse and the hedge hog and with great justice he extends the analogy to the marmot which like the rest is seen to sleep all the winter This torpid state continues as long as the cause which produces it continues and it is very probable that it might be lengthened out beyond its usual term by artificially prolonging the cold if for instance the animal were rolled up in wool and placed in a cold cellar nearly approaching to but not quite so cold as an ice house for that would kill them outright it would remain perhaps a whole year in its state of insensibility However this be if the heat of the air be above ten degrees these animals are seen to revive and if it be continued in that degree of temperature they do not become torpid but eat and sleep at proper intervals like all other quadrupeds whatever

From the above account we may form some conception of the state in which these animals continue during the winter As in some disorders where the circulation is extremely languid the appetite is diminished in proportion so in these the blood scarcely moving or only moving in the greater vessels they want no nourishment to repair what is worn away by its motions They are seen indeed by slow degrees to become leaner in proportion to the slow attrition

* Buffon vol xv Loirs

of their fluids ; but this is not perceptible, except at the end of some months. Man is often known to gather nourishment from the ambient air ; and these also may, in some measure, be supplied in the same manner, and having sufficient motion in their fluids to keep them from putrefaction, and just sufficient nourishment to supply the waste of their languid circulation, they continue rather feebly alive than sleeping.

These animals produce but once a year, and usually bring forth but three or four at a time. They grow very fast, and the extent of their lives is not above nine or ten years ; so that the species is neither numerous nor very much diffused. They are chiefly found in the Alps, where they seem to prefer the brow of the highest mountains to the lowest ranges, and the sunny side to that in the shade. The inhabitants of the country where they chiefly reside, when they observe the hole, generally stay till winter before they think proper to open it ; for if they begin too soon, the animal wakes, and as it has a surprising faculty of digging, makes its hole deeper in proportion as they follow. Such as kill it for food, use every art to improve the flesh, which is said to have a wild taste, and to cause vomitings *. They, therefore, take away the fat, which is in great abundance, and salt the remainder, drying it somewhat in the manner of bacon. Still, however, it is said to be very indifferent eating. This animal is found in Poland under the denomination of the *Bobak*, entirely resembling that of the Alps, except that the latter has a toe more upon its fore-foot than the former. It is found also in Siberia under the name of the *Jevaska*, being rather smaller than either of the other two. Lastly, it is found in Canada by the appellation of the *Monax*, differing only from the rest in having a bluish snout and a longer tail.

THE AGOUTI †

FROM the marmot, which differs from the hare so much in the length of its fur, we go to the Agouti, another species

* Dictionnaire Raisonné, vol. iii. p. 29.

† This animal, together with the Paca, Apeia, Guinea Pig, Capibara, and a few other species, are now arranged under the general appellation,

equally differing in the shortness of its hair. These bear some rude resemblance to the hare and the rabbit in their form and manner of living but sufficiently differing to require a particular description. The first of these and that the largest as was hinted above is called the *agouti*. This animal is found in great abundance in the southern parts of America and has by some been called the *rabbit* of that continent. But though in many respects it resembles the rabbit yet still in many more it differs and is without all doubt an animal peculiar to the new world only. The *agouti* is about the size of a rabbit and has a herd very much resembling it except that the ears are very short in comparison. It resembles the rabbit also in the arched form of its back in the hind legs being longer than the fore and in having four great cutting teeth two above and two below but then it differs in the nature of its hair which is not soft and downy as in the rabbit but hard and bristly like that of a sucking pig and of a reddish brown colour. It differs also in the tail which is even shorter than the rabbit and entirely destitute of hair. Lastly it differs in the number of its toes having but three on the hinder feet whereas the rabbit has five. All these distinctions however do not countervail against its general form which resembles that of a rabbit and most travellers have called it by that name.

As this animal differs in form it differs still more in habits and disposition. As it has the hair of a hog so also it has its voraciousness*. It eats indiscriminately of all things and when satiated hides the remainder like the dog or the fox for a future occasion. It takes a pleasure in gnawing and spoiling every thing it comes near. When irritated it
back
and like the rabbit it
with
its hind feet. It does not
but
burrows in the hollows of trees. Its ordinary food consists

of Cavy. They
teeth in each jaw
have from four
hinder the tail

They are inhabitants of warmer regions live entirely on vegetable substances reside under ground or beneath the roots of trees and move with a slow and kind of leaping pace.

* Buffon

of the roots of the country, potatoes, and yams, and such fruits as fall from the trees in autumn. It uses its fore-paws, like the squirrel, to carry its food to its mouth, and as its hind feet are longer than the fore, it runs very swiftly upon plain ground or up a hill, but upon a descent it is in danger of falling. Its sight is excellent, and its hearing equals that of any other animal; whenever it is whistled to, it stops to hearken. The flesh of such as are fat and well fed is tolerable food, although it has a peculiar taste, and is a little tough. The French dress it like a sucking-pig, as we learn from M^r. Buffon's account, but the English dress it with a pudding in its belly, like a hare. It is hunted by dogs; and whenever it has got into a sugar-ground, where the canes cover the place, it is easily overtaken, for it is embarrassed every step it takes, so that a man may easily come up with it without any other assistance. When in the open country, it usually runs with great swiftness before the dogs, until it gains its retreat, within which it continues to hide, and nothing but filling the hole with smoke can force it out. For this purpose, the hunter burns fagots or straw at the entrance, and conducts the smoke in such a manner that it fills the whole cavity. While this is doing, the poor little animal seems sensible of its danger, and begs for quarter with a most plaintive cry, seldom quitting its hole till the utmost extremity. At last, when half-suffocated, it issues out, and trusts once more to its speed for protection. When still forced by the dogs, and incapable of making good a retreat, it turns upon the hunters, and with its haui bustling like a hog, and standing upon its hind-feet, it defends itself very obstinately. Sometimes it bites the legs of those that attempt to take it, and will take out the piece wherever it fixes its teeth *

Its cry, when disturbed or provoked, resembles that of a sucking-pig. If taken young, it is easily tamed, continues to play harmlessly about the house, and goes out and returns of its own accord. In a savage state it usually continues in the woods, and the female generally chooses the most obscure parts to bring forth her young. She there prepares a bed of leaves and dry grass, and generally

brings forth two at a time. She breeds twice or thrice a year and carries her young from one place to another as convenience requires, in the manner of a cat. She generally lodges them when three days old in the hollow of a tree suckling them but a very short time for they soon come to perfection and it should consequently follow that they soon grow old.

THE PACA

THE PACA is an animal also of South America very much resembling the former and like it has received the name of the *American rabbit* but with as little propriety. It is about the size of a hare or rather larger and in figure somewhat like a sucking pig which it also resembles in its grunting and its manner of eating. It is however most like the agouti although it differs in several particulars. Like the agouti it is covered rather with coarse hair than a downy fur. But then it is beautifully marked along the sides with small ash coloured spots upon an amber coloured ground whereas the agouti is pretty much of one reddish colour. The paca is rather more thick and corpulent than the agouti its nose is shorter and its hind feet have five toes whereas the agouti has but three. As to the rest this animal bears some distant resemblance to a rabbit, the ears are naked of hair and somewhat sharp the upper jaw is somewhat longer than the lower the teeth the shape of the head and the size of it are like to those of a rabbit. It has a short tail like wise though not tufted and its hinder legs are longer than the fore. It also burrows in the ground like that animal and from this similitude alone travellers might have given it the name.

The paca does not make use of its fore paws like the squirrel or the agouti to carry its food to the mouth but hunts for it on the ground and roots like a hog. It is generally seen along the banks of rivers and is only to be found in the moist and warm countries of South America. It is a very fat animal and in this respect much preferable to the agouti that is most commonly found lean. It is eaten skin and all like a young pig and is considered as a great delicacy. Like the former little animal it defends

itself to the last extremity, and is very seldom taken alive. It is persecuted not only by man, but by every beast and bird of prey, who all watch its motions, and, if it ventures at any distance from its hole, are sure to seize it. But although the race of these little animals is thus continually destroyed, it finds some refuge in its hole, from the general combination; and breeds in such numbers, that the diminution is not perceptible.

To these animals may be added others, very similar, both in form and disposition; each known by its particular name in its native country, but which travellers have been contented to call rabbits or hares, of which we have but indistinct notice. The *TAPETI*, or the *BRASILIAN RABBIT*, is in shape like our English ones, but is much less, being said to be not above twice the size of a dormouse. It is reddish on the forehead, and a little whitish under the throat. It is remarkable for having no tail; but it has long ears, with whiskers, like our rabbits, and black eyes. It does not burrow, like ours; but lives at large, like the hare.

The *APEREA* is called also by some the *BRASILIAN RABBIT*, being an animal that seems to partake of the nature of a rabbit and a rat. The ears are like those of a rat, being short and round, but the other parts are like those of a rabbit, except that it has but three toes on the hinder legs, like the agouti.

To these imperfect sketches of animals little known, others less known might be added, for as nature becomes more diminutive, her operations are less attentively regarded. I shall only, therefore, add one animal more to this class, and that very well known; I mean the Guinea-pig, which Brisson places among those of the rabbit kind, and as I do not know any other set of animals with which it can be so well compared, I will take leave to follow his example.

THE GUINEA-PIG

THE Guinea-pig is a native of the warmer climates; but has been so long rendered domestic, and so widely diffused, that it is now become common in every part of the world. There are few unacquainted with the figure of this little animal; in some places it is considered as the principal favourite, and is often found even to displace the lap-dog.

ANIMALS OF

It is less than a rabbit and its legs are shorter they are scarcely seen except when it moves and the neck also is so short that the head seems stuck upon the shoulders. The ears are short thin and transparent the hair is like that of a sucking pig from whence it has taken the name and it wants even the vestiges of a tail. In other respects it has some similitude to the rabbit. When it moves its body lengthens like that animal and when it is at rest it gathers up in the same manner. Its nose is formed with the rabbit lip except that its nostrils are much further asunder. Like all other animals in a domestic state its colours are different some are white some are red and others both red and white. It differs from the rabbit in the number of its toes having four toes on the feet before and but three on those behind. It strokes its head with the fore feet like the rabbit and like it sits upon the hind feet for which purpose there is a naked callous skin on the back part of the legs and feet.

These animals are of all others the most helpless and inoffensive. They are scarcely possessed of courage sufficient to defend themselves against the merriest of all quadrupeds a mouse. Their only animosity is exerted against each other for they will often fight very obstinately and the stronger is often known to destroy the weaker. But against all other aggressors their only remedy is patience and non resistance. How therefore these animals in a savage state could contrive to protect themselves I have not been able to learn as they want strength swiftness and even the natural instinct so common to almost every other creature.

As to their manner of living among us they owe their lives entirely to our unceasing protection. They must be constantly attended shielded from the excessive colds of the winter and secured against all other domestic animals which are apt to attack them from every motive either of appetite jealousy or experience of their pusillanimous nature. Such indeed is their stupidity that they suffer themselves to be devoured by the cats without resistance and differing from all other creatures the female sees her young destroyed without once attempting to protect them. Their usual food is brin parsley or cabbage leaves but there is scarce a

* This history is partly taken from the *Amantitates Academicæ*
v l iv } 202

vegetable cultivated in our gardens that they will not gladly devour. The carrot-top is a peculiar dainty, as also salad; and those who would preserve their healths, would do right to vary their food; for if they be continued on a kind too succulent or too dry, the effects are quickly perceived upon their constitution. When fed upon recent vegetables, they seldom drink. But it often happens that, conducted by nature, they seek drier food, when the former disagrees with them. They then gnaw clothes, paper, or whatever of this kind they meet with, and on these occasions they are seen to drink like most other animals, which they do by lapping. They are chiefly fond of new milk; but, in case of necessity, are content with water.

They move pretty much in the manner of rabbits, though not near so swiftly; and when confined in a room, seldom cross the floor, but generally keep along the wall. The male usually drives the female on before him, for they never move abreast together, but constantly the one seems to tread in the footsteps of the preceding. They chiefly seek for the darkest recesses, and the most intricate retreats, where, if hay be spread as a bed for them, they continue to sleep together, and seldom venture out but when they suppose all interruption removed. On these occasions they act as rabbits, they swiftly move forward from their bed, stop at the entrance, listen, look round, and if they perceive the slightest approach of danger, they run back with precipitation. In very cold weather, however, they are more active, and run about in order to keep themselves warm.

They are a very cleanly animal, and very different from that whose name they go by. If the young ones happen to fall into the dirt, or be any other way discomposed, the female takes such an aversion to them, that she never permits them to visit her more. Indeed, her whole employment, as well as that of the male, seems to consist in smoothing their skins, in disposing their hair, and improving its gloss. The male and female take this office by turns; and when they have thus brushed up each other, they then bestow all their concern upon their young, taking particular care to make their hair lie smooth, and biting them if they appear refractory. As they are so solicitous for elegance themselves, the place where they are kept must be regularly cleaned, and a new bed of hay provided for them at least every week. Being

natives of a warm climate they are naturally chilly in ours cleanliness therefore assists warmth and expels moisture They may be thus reared without the aid of any artificial heat but in general there is no keeping them from the fire in winter if they be once permitted to approach it

When they go to sleep they lie flat on their bellies pretty much in their usual posture except that they love to have their fore feet higher than their hinder For this purpose they turn themselves several times round before they lie down to find the most convenient situation They sleep like the hare with their eyes half open and continue extremely watchful if they suspect danger The male and female are never seen both asleep at the same time but while he enjoys his repose she remains upon the watch silently continuing to guard him and her head turned towards the place where he lies When she supposes that he has left his turn she then awakes him with a kind of murmuring noise goes to him forces him from his bed and lies down in his place He then performs the same good turn for her and continues watchful till she also has done sleeping

These animals are exceedingly voracious and generally are capable of coupling at six weeks old The female never goes with young above five weeks and usually bring forth from three to five at a time and this not without pain But what is very extraordinary the female admits the male the very day she has brought forth and becomes again pregnant so that their multiplication is astonishing She suckles her young but about twelve or fifteen days and during that time does not seem to know her own for if the young of any other be brought though much older she never drives them away but suffers them even to draw to the disadvantage of her own immediate offspring They are produced with the eyes open like all others of the hare kind and in about twelve hours equal even to the dam in agility Although the dam has but two teats yet she abundantly supplies them with milk and they are also capable of feeding upon vegetables almost from the very beginning If the young ones are permitted to continue together the stronger is in all other societies soon begin to govern the weak Their contentions are often long and obstinate and their jealousies very apparent Their disputes are usually for the warmest place or the most agreeable food If one

of them happens to be more fortunate in this respect than the rest, the strongest generally comes to dispossess it of its advantageous situation. Their manner of fighting, though terrible to them, is ridiculous enough to a spectator. One of them seizes the hair on the nape of the other's neck with its fore-teeth, and attempts to tear it away, the other, to retaliate, turns its hinder parts to the enemy, and kicks up behind like a horse, and with its hinder claws scratches the sides of its adversary; so that sometimes they cover each other with blood. When they contend in this manner, they gnash their teeth pretty loudly, and this is often a denunciation of mutual resentment.

These, though so formidable to each other, yet are the most timorous creatures upon earth, with respect to the rest of animated nature: a falling leaf disturbs them, and every animal overcomes them. From hence they are difficultly tamed; and will suffer none to approach them, except the person by whom they are fed. Their manner of eating is something like that of the rabbit; and, like it, they appear also to chew the cud. Although they seldom drink, they make water every minute. They grunt somewhat like a young pig; and have a more piercing note to express pain. In a word, they do no injury, but then, except the pleasure they afford the spectator, they are of very little benefit to mankind. Some, indeed, dress and eat them, but their flesh is indifferent food, and by no means a reward for the trouble of rearing them. This, perhaps, might be improved, by keeping them in a proper warren, and not suffering them to become domestic: however, the advantages that would result from this would be few, and the trouble great; so that it is likely they will continue an useless, inoffensive dependent, rather propagated to satisfy caprice than to supply necessity.

BOOK VI

ANIMALS OF THE RAT HEDGEHOG ETC KINDS

CHAP I

THE RAT KIND *

WERE it necessary to distinguish animals of the rat kind from all others we might describe them as having two large cutting teeth like the hare kind in each jaw is covered with hair and as not ruminating. These distinctions might serve to guide us had we not too near an acquaintance with this noxious race to be mistaken in their kind. Their numbers their minuteness their vicinity their vast multiplication all sufficiently contribute to press them upon our observation and remind us of their existence. Indeed if we look through the different ranks of animals from the largest to the smallest from the great elephant to the diminutive mouse we shall find that we suffer greater injuries from the contemptible meanness of the one than the formidable invasions of the other. Against the elephant the rhinoceros or the lion we can oppose united strength and by art make up the deficiencies of natural power these we have driven into their native solitudes and obliged to continue at a distance in the most inconvenient regions and unhealthy climates. But it is otherwise with the little teasing rat. I am now describing no arts can be exerted against their unresisting timidity they may be at once destroyed and yet the breach be repaired in the space of a very few weeks and in proportion as nature has denied them force it has supplied the defect by their fecundity.

* The e have the upper front teeth 1 ed 2 sh pe 1 three g in lers on each side in each jaw though sometime only two and have perfect collar bones. There are forty six distinct species

THE GREAT RAT

THE animal best known at present, and in every respect the most mischievous, is the Great Rat, which, though but a new comer into this country, has taken too secure a possession to be ever removed. This hateful and rapacious creature, though sometimes called the *rat of Norway*, is utterly unknown in all the northern countries, and, by the best accounts I can learn, comes originally from the Levant. Its first arrival, as I am assured, was upon the coasts of Ireland, in those ships that traded in provisions to Gibraltar; and perhaps we owe to a single pair of these animals, the numerous progeny that now infests the whole extent of the British empire.

This animal, which is called by Mr. Buffon the *surmalot*, is in length about nine inches, its eyes are large and black, the colour of the head, and the whole upper part of the body, is of a light brown, mixed with a tawny and ash colour. The end of the nose, the throat, and belly, are of a dirty white, inclining to gray; the feet and legs are almost bare, and of a dirty pale flesh colour, the tail is as long as the body, covered with minute dusky scales mixed with a few hairs, and adds to the general deformity of its detestable figure. It is chiefly in the colour that this animal differs from the *black rat*, or the *common rat*, as it was once called, but now common no longer. This new invader, in a very few years after its arrival, found means to destroy almost the whole species, and to possess itself of their retreats.

But it was not against the black rat alone that its rapacity was directed, all other animals of inferior strength shared the same misfortunes. The contest with the black rat was of short continuance. As it was unable to contend, and had no holes to fly to for retreat, but where its voracious enemy could pursue, the whole race was soon extinguished. The frog also was an animal equally incapable of combat or defence. It had been designedly introduced into the kingdom of Ireland some years before the Norway rat, and it was seen to multiply amazingly. The inhabitants were pleased with the propagation of a harmless animal, that served to rid their fields of insects;

and even the prejudices of the people were in its favour as they supposed that the frog contributed to render their waters more wholesome. But the Norway rat soon put a stop to their increase as these animals were of an amphibious nature they pursued the frog to its lakes and took it even in its own natural element. I am, therefore assured that the frog is once more almost extinct in that kingdom, and that the Norway rat having no more enemies left there to destroy is grown less numerous also.

We are not likely therefore to gain by the destruction of our old domestics since they are replaced by such mischievous successors. The Norway rat has the same disposition to injure us with much greater power of mischief. It burrows in the banks of rivers ponds and ditches and is every year known to do incredible damage to those mounds that are raised to conduct streams or to prevent rivers from overflowing. In these holes which it forms pretty near the edge of the water it chiefly resides during the summer where it lives upon small animals fish and corn. At the approach of winter it comes nearer the farm houses burrows in their corn eats much and damages still more than it consumes. But nothing that can be eaten seems to escape its voracity. It destroys rabbits poultry and all kinds of game and like the pole cat kills much more than it can carry away. It swims with great ease dives with great celerity and easily thins the fish pond. In short scarcely any of the feebler animals escape its rapacity except the mouse which shelters itself in its little hole where the Norway rat is too big to follow.

These animals frequently produce from ten to fifteen at a time * and usually bring forth three times a year. This great increase would quickly be found to overrun the whole country and render our assiduity to destroy them fruitless were it not happily for us that they eat and destroy each other. The same insatiable appetite that impels them to indiscriminate carnage also incites the strongest to devour the weakest even of their own kind. The large male rat generally keeps in a hole by itself and is as dreaded by its own species as the most formidable

enemy In this manner the number of these vermin is kept within due bounds, and when their increase becomes injurious to us, it is repressed by their own incapacity.

But beside their own enmities among each other, all the stronger carnivorous quadrupeds have natural antipathies against them. The dog, though he detests their flesh, yet openly declares his alacrity to pursue them; and attacks them with great animosity. Such as are trained up to killing these vermin, dispatch them often with a single squeeze but those dogs that shew any hesitation, are sure to come off but indifferently, for the rat always takes the advantage of a moment's delay, and, instead of waiting for the attack, becomes the aggressor, seizing its pursuer by the lip, and inflicting a very painful and dangerous wound. From the inflammation, and other angry symptoms that attend this animal's bite, some have been led to think that it was in some measure venomous; but it is likely that the difficulty of the wound's healing, arises merely from its being deep, and lacerated by the teeth, and is rather a consequence of the figure of the instruments that inflict it, than any venom they may be supposed to possess.

The cat is another formidable enemy of this kind, and yet the generality of our cats neither care to attack it, nor to feed upon it when killed. The cat is a more prudent hunter than the dog, and will not be at the pains to take on combat with an enemy that is not likely to repay her time and danger. Some cats, however, will pursue and take the rat, though often not without an obstinate resistance. If hungry, the cat will sometimes eat the head, but, in general, she is content merely with her victory.

A foe much more dangerous to these vermin is the weasel. This animal pursues them with avidity, and being pretty nearly of their own size, follows them into their holes, where a desperate combat ensues. The strength of each is pretty near equal, but the arms are very different. The rat, furnished with four long tusks at the extremity of its jaw, rather snaps than bites, but the weasel, where it once fastens, holds, and continuing also to suck the blood at the same time, weakens its antagonist, and always obtains the victory. Mankind have contrived several other methods of destroying these noxious intruders, ferrets, traps, and poison; but of all other poisons, I am told the

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various ground and mixed with man is the most certain as it is the first dangerous to this species I will subjoin as a variety the BLACK RAT

mentioned above greatly resembling the former in figure but very distinct in nature as appears from their mutual antipathy This animal was formerly as mischievous as it was common but at present it is almost utterly exterminated by the great rat on which I do not remember ever to have seen one It is said to be possessed of all the voracious and unnatural appetites of the former though as it is less they may probably be less noxious Its length is about seven inches and the tail is of a deep iron grey bordering upon black except the belly which is of a dirty cinereous hue They have propagated in America in great numbers being originally introduced from Europe and as they seem to keep their ground wherever they get footing they are now become the most noxious animals in that part of the world

To this also we may subjoin the BLACK WATER RAT about the same size with the latter with a larger head a blunter nose less eyes and shorter ears and the tip of its tail a little white It was supposed by Ray to be web footed but this has been found to be a mistake It never frequents much resembling those of its kind It feeds on fish and ponds where it burrows and breeds It feeds on fish frogs and insects and in some countries it is ent on fasting days *

THE MOUSE

AN animal equally mischievous and equally well known with the former is the mouse Timid cautious and active all its dispositions are similar to those of the rat except

* Dr Shaw in his general zoology informs us that a gentleman traveling through Necklenburg about thirty years ago was witness to the following curious circumstance in the post house at New Stargard After dinner the landlord placed on the floor a large dish of soup and gave a loud whistle Immediately then came into the room a mastiff ga-e a fine Angora cat an old rat and a remarkably large rat with a bell about its neck The four animals went to the dish and without disturbance each other fed together after which the dog caught a rat lay before the fire while the men hopped about the room The landlord

with fewer powers of doing mischief * Fearful by nature, but familiar from necessity, it attends upon mankind, and comes an unbidden guest to his most delicate entertainments Fear and necessity seem to regulate all its motions; it never leaves its hole but to seek provision, and seldom ventures above a few paces from home. Different from the rat, it does not go from one house to another, unless it be forced; and as it is more easily satisfied, it does much less mischief

Almost all animals are tamed more difficultly in proportion to the cowardice of their natures The truly bold and courageous easily become familiar, but those that are always fearful are ever suspicious The mouse being the most feeble, and consequently the most timid of all quadrupeds, except the Guinea-pig, is never rendered thoroughly familiar; and, even though fed in a cage, retains its natural apprehensions. In fact, it is to these alone that it owes its security † No animal has more enemies, and few so incapable of resistance The owl, the cat, the snake, the hawk, the weasel, the rat itself, destroy this species by millions, and it only subsists by its amazing fecundity.

The mouse brings forth at all seasons, and several times in a year Its usual number is from six to ten These in less than a fortnight are strong enough to run about and shift for themselves. They are chiefly found in farmers' yards, and among their corn, but are seldom in those ricks that are much infested with rats They generally choose the south-west side of the rick, from whence most rain is expected, and from thence they often, of an evening, venture forth to drink the little drops either of rain or dew that hang at the extremities of the straw ‡ Aristotle gives us an idea of their prodigious fecundity, by assuring us, that having put a mouse with young into a vessel of corn, in some time after he found a hundred and twenty mice, all sprung from one original The early growth of this animal implies also the short duration of its life, which seldom

after accounting for the familiarity which existed among the animals, informed his guest that the rat was the most useful of the four, for the noise he made had completely freed the house from the rats and mice with which it was before infested

* Buffon, vol xv p 145

† *E volucris hirundines sunt indociles, e terrestibus mures* PLIN

‡ Buffon, vol xv p 147,

lasts above two or three years. This species is very much diffused being found in almost all parts of the ancient continent and having been exported to the new. They are animals that while they fear human society closely attend it and although enemies to man are never found but near those places where he has fixed his habitation. Numerous ways have been found for destroying them and Gesner has minutely described the variety of traps by which they are taken. Our Society for the Encouragement of Arts and Manufactures proposed a reward for the most ingenious contrivance for that purpose and I observed almost every candidate passing off descriptions as inventions of his own. I thought it was cruel to detect the plagiarism or frustrate the humble ambition of those who would be thought the inventors of a mouse trap.

To this species merely to avoid teasing the reader with a minute description of animals very inconsiderable and very nearly alike I will add that of the **LONG TAILED FIELD MOUSE** which is larger than the former of a colour very nearly resembling the Norway rat, and chiefly found in fields and gardens. They are extremely voracious and hurtful in gardens and young nurseries where they are killed in great numbers. However their fecundity quickly repairs the destruction.

Nearly resembling the former but larger (for it is six inches long) is the **SHORT TAILED FIELD MOUSE** which as its name implies has the tail much shorter than the former it being not above an inch and a half long and ending in a small tuft. Its colour is more inclining to that of the domestic mouse the upper part being blackish and the under of an ash colour. This as well as the former are remarkable for laying up provision against winter and Mr Buffon assures us they sometimes have a store of above a bushel at a time.

We may add also the **SIREN MOUSE** to this species of minute animals being about the size of the domestic mouse but differing greatly from it in the form of its nose which is very long and slender. The teeth also are of a very singular form and twenty eight in number whereas the common number in the rat kind is usually not above sixteen. The two upper fore teeth are very sharp and on each side

of them there is a kind of wing or beard, like that of an arrow, scarcely visible but on a close inspection. The other teeth are placed close together, being very small, and seeming scarcely separated; so that with respect to this part of its formation, the animal has some resemblance to the viper. However, it is a very harmless little creature, doing scarcely any injury. On the contrary, as it lives chiefly in the fields, and feeds more upon insects than corn, it may be considered rather as a friend than an enemy. It has a strong, disagreeable smell, so that the cat, when it is killed, will refuse to eat it. It is said to bring four or five young at a time.

THE DORMOUSE

These animals may be distinguished into three kinds; the GRAYISH DORMOUSE, which Mr. Buffon calls the LOIR; the RUDDLE, which he calls the LEROT; the LASS, which he denominates the MUSCARDIN. They differ from each other in size, the largest being equal to a rat, the least being no bigger than a mouse. They all differ from the rat in having the tail tufted with hair, in the manner of a squirrel, except that the squirrel's tail is flat, resembling a fan, and theirs round, resembling a brush. The lerot differs from the loir by having two black spots near the eyes, the muscardin differs from both in the whitish colour of its hair on the back. They all three agree in having black sparkling eyes, and the whiskers partly white and partly black. They agree in their being stupified, like the marmot, during the winter, and in their hoarding up provisions to serve them in case of a temporary revival.

They inhabit the woods or very thick hedges, forming their nests in the hollow of some tree, or near the bottom of a close shrub, humbly content with continuing at the bottom, and never aspiring to sport among the branches. Towards the approach of the cold season, they form a little magazine of nuts, beans, or acorns, and having laid in their hoard, shut themselves up with it for the winter. As soon as they feel the first advances of the cold, they prepare to lessen its effect by rolling themselves up in a ball, and thus exposing the smallest surface to the weather. But it often happens that the warmth of a sunny day, or an accidental change from cold to heat, thaws then nearly stagnant fluids, and they

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reine On such occasions they have their provisions laid in and they have not far to seek for their support In this manner they continue usually asleep but sometimes waking for about five months in the year seldom venturing from their retreats and consequently but rarely seen Their nests are lined with moss grass and dead leaves they usually bring forth three or four young at a time and that but once a year in the spring

THE MUSK RAT

Of these animals of the rat kind but with a musky smell there are also three distinctions as of the former the ONDATRA the DESMAN and the PILORI The ondatra is a native of Canada the desman of Lapland and the pilori of the West India islands The ondatra differs from all others of its kind in having the tail flattened and carried edge ways the desman has a long extended snout like the shrew mouse and the pilori a short tail as thick at one end as the other They all resemble each other in being fond of water but particularly in that musky odour from whence have taken their name

Of these the ONDATRA is the most remarkable and has been the most minutely described * This animal is about the size of a small rabbit but has the hair the colour and the tail of a rat except that it is flatted on the sides as mentioned above But it is still more extraordinary upon other accounts and different from all other animals whatever It is so formed that it can contract and enlarge its body at pleasure It has a muscle like that of horses by which they move their hides lying immediately under the skin and that furnished with such a power of contraction together with such an elasticity in the false ribs that this animal can creep into a hole where others seemingly much less cannot follow The female is remarkable also for two distinct apertures one for urine the other for propagation The musk smell is much stronger at one particular season of the year than any other and the marks of the sex seem to appear and disappear in the same manner The ondatra in some measure resembles the beaver in its nature and disposition They both live in society during

* Buffon vol xx p 4

winter ; they both form houses of two feet and a half wide, in which they reside several families together. In these they do not assemble to sleep as the marmout, but purely to shelter themselves from the rigour of the season. However, they do not lay up magazines of provision like the beaver ; they only form a kind of covert-way to and round their dwelling, from whence they issue to procure water and roots, upon which they subsist. During winter their houses are covered under a depth of eight or ten feet of snow, so that they must lead out a cold, gloomy, and necessitous life, during its continuance. During summer they separate two by two, and feed upon the variety of roots and vegetables that the season offers. They then become extremely fat, and are much sought after, as well for their flesh as their skins, which are very valuable. They then also acquire a very strong scent of musk, so pleasing to an European, but which the savages of Canada cannot abide. What we admire as a perfume, they consider as a most abominable stench, and call one of their rivers, on the banks of which this animal is seen to burrow in numbers, by the name of the *stinking river*, as well as the rat itself, which is denominated by them the *stinkard*. This is a strange diversity among mankind, and, perhaps, may be ascribed to the different kinds of food among different nations. Such as chiefly feed upon rancid oils, and putrid flesh, will often mistake the nature of scents, and, having been long used to ill smells, will, by habit, consider them as perfumes. Be this as it will, although these nations of northern savages consider the musk rat as intolerably foetid, they nevertheless regard it as very good eating ; and, indeed, in this they imitate the epicures of Europe very exactly, whose taste seldom relishes a dish till the nose gives the strongest marks of disapprobation. As to the rest, this animal a good deal resembles the beaver in its habits and disposition, but, as its instincts are less powerful, and its economy less exact, I will reserve for the description of that animal a part of what may be applicable to this.

THE CRICETUS

THE Cricetus, or German Rat, which M^r Buffon calls the *hamster*, greatly resembles the water-rat in its size, small eyes, and the shortness of its tail. It differs in colour, being rather browner, like the Norway rat, with the belly

and legs of a dirty yellow. But the marks by which it may be distinguished from all others are two pouches like those of a biboon on each side of its jaw under the skin into which it can cram a large quantity of provision. These bags are oblong and of the size when filled of a large walnut. They open into the mouth and fall back along the neck to the shoulder. Into these the animal can thrust the surplus of those fruits or grains it gathers in the fields such as wheat peas or acorns. When the immediate calls of hunger are satisfied it then fills to filling these and thus loaded with two great bunches on each side of the jaw returns home to its hole to deposit the spoil as a store for the winter. The size, the fecundity and the voraciousness of this animal render it one of the greatest pests in the countries where it is found, and every method is made use of to destroy it *

But although this animal is very noxious with respect to man yet considered with regard to those instincts which conduce to its own support and convenience it deserves our admiration †. Its hole offers a very curious object for contemplation and shews a degree of skill superior to the rest of the rat kind. It consists of a variety of apartments fitted up for the different occasions of the little inhabitant. It is generally made on an inclining ground and always has two entrances one perpendicular and the other oblique though if there be more than one in a family there are as many perpendicular holes as there are individuals below. The perpendicular hole is usually that through which they go in and out the oblique serves to give a thorough air to keep the retreat clean and in case one hole is stopped to give an exit at this. Within about a foot of the perpendicular hole the animal makes two more where are deposited the family's provisions. These are much more spacious than the former and are large in proportion to the quantity of the store. Beside these there is still another apartment warmly lined with grass and straw where the female brings forth her young all these

* Among animals of this kind which are furnished with pouches on

† The size is
the colour
to the

cheeks are of a very large size shaped somewhat like an egg reach to the ground and have the appearance of a pair of inflated bladders

‡ Buffon vol xx : 1 159

communicate with each other, and all together take up a space of ten or twelve feet in diameter. These animals furnish their store-houses with dry corn, well cleaned, they also lay in corn in the ear, and beans and peas in the pod. These, when occasion requires, they afterwards separate, carrying out the pods and empty ears by their oblique passage. They usually begin to lay in at the latter end of August, and, as each magazine is filled, they carefully cover up the mouth with earth, and that so neatly that it is no easy matter to discover where the earth has been removed. The only means of finding out their retreats are, therefore, to observe the oblique entrance, which generally has a small quantity of earth before it, and this, though often several yards from their perpendicular retreat, leads those who are skilled in the search to make the discovery. Many German peasants are known to make a livelihood by finding out and bringing off their hoards, which, in a fruitful season, often furnish two bushels of good grain in each apartment.

Like most others of the rat kind, they produce twice or thrice a year, and bring five or six at a time. Some years they appear in alarming numbers, at other times they are not so plentiful. The moist seasons assist their propagation; and it often happens on such years that their devastations produce a famine all over the country. Happily, however, for mankind, these, like the rest of their kind, destroy each other, and of two that Mr. Buffon kept in a cage, male and female, the latter killed and devoured the former. As to the rest, their fur is considered as very valuable, the natives are invited by rewards to destroy them; and the weasel kind seconds the wishes of government with great success. Although they are usually found brown on the back and white on the belly, yet many of them are observed to be gray, which may probably arise from the difference of age.

THE LEMMING

HAVING considered various kinds of these noxious little animals that elude the indignation of mankind, and subsist by their number, not their strength, we come to a species more bold, more dangerous, and more numerous than any of the former. The lemming, which is a native of Scandi-

鼠 is often seen to pour down in myriads from the northern mountains and like a pestilence destroy all the productions of the earth. It is described as being larger than a dormouse with a bushy tail though shorter. It is covered with thin hair of various colours. The extremity of the upper part of the head is black as are likewise the neck and shoulders but the rest of the body is reddish intermixed with small black spots of various figures as far as the tail which is not above half an inch long. The eyes are little and black the ears round and inclining towards the back the legs before are short and those behind longer which gives it a great degree of swiftness. But what it is much more remarkable for than its figure are its amazing fecundity and extraordinary migrations.

In wet seasons all of the rat kind are known to propagate more than in dry but this species in particular is so assisted in multiplying by the moisture of the weather that the inhabitants of Lapland sincerely believe that they drop from the clouds and that the same magazines that furnish hail and snow pour the lemming also upon them. In fact after long run these animals set forward from their native mountains and several millions in a troop deluge the whole plain with their numbers *. They move for the most part in a square marching forward by night, and lying still by day. Thus like an animated torrent they are often seen more than a mile broad covering the ground and that so thick that the hindmost touches its leader. It is in vain that the poor inhabitant resists or attempts to stop their progress they still keep moving forward and though thousands are destroyed myriads are seen to succeed and make their destruction impracticable. They generally move in lines which are about three feet from each other and exactly parallel. Their march is always directed from the north west to the south east and regularly conducted from the beginning. Wherever their motions are turned nothing can stop them they go directly forward impelled by some strange power and from the time they first set out they never once think of retreating. If a lake or a river happens to interrupt their progress they all together take the water and swim over it a fire a deep well or a torrent does not turn them out of their straight lined direction they boldly plunge into the flames or leap

* Phil Trans vol 11 p 612

down the well, and are sometimes seen climbing up on the other side. If they are interrupted by a boat across a river while they are swimming, they never attempt to swim round it, but mount directly up its sides; and the boatmen, who know how vain resistance in such a case would be, calmly suffer the living torrent to pass over, which it does without further damage. If they meet with a stack of hay or corn that interrupts their passage, instead of going over it, they gnaw their way through; if they are stopped by a house in their course, if they cannot get through it, they continue there till they die. It is happy, however, for mankind, that they eat nothing that is prepared for human subsistence; they never enter a house to destroy the provisions, but are contented with eating every root and vegetable that they meet. If they happen to pass through a meadow, they destroy it in a very short time, and give it an appearance of being burnt up and strewed with ashes. If they are interrupted in their course, and a man should imprudently venture to attack one of them, the little animal is no way intimidated by the disparity of strength, but furiously flies up at its opponent, and barking somewhat like a puppy, wherever it fastens does not easily quit the hold. If at last the leader be forced out of its line, which it defends as long as it can, and be separated from the rest of its kind, it sets up a plaintive cry, different from that of angels, and, as some pretend to say, gives itself a voluntary death, by hanging itself on the fork of a tree.

An enemy so numerous and destructive would quickly render the countries where they appear utterly uninhabitable, did it not fortunately happen, that the same rapacity that animates them to destroy the labours of mankind, at last impels them to destroy and devour each other. After committing incredible devastations, they are at last seen to separate into two armies, opposed with deadly hatred, along the coast of the larger lakes and rivers. The Laplanders, who observe them thus drawn up to fight, instead of considering their mutual animosities as an happy riddance of the most dreadful pest, form ominous prognostics from the manner of their arrangement. They consider their combats as a presage of war, and expect an invasion from the Russians or the Swedes, as the sides next those kingdoms happen to conquer. The two divisions, however, continue their

engagements and animosity until one party overcomes the other. From that time they utterly disappear nor is it well known what becomes of either the conquerors or the conquered. Some suppose that they rush headlong into the sea others that they kill themselves as some are found hanging on the forked branches of a tree and others still that they are destroyed by the young spring herbage. But the most probable opinion is that having devoured the vegetable productions of the country and having nothing more to subsist on they then fall to devouring each other and having habituated themselves to that kind of food continue it. However this be they are often found dead by thousands and their carcasses have been known to infect the air for several miles round so as to produce very malignant disorders. They seem also to infect the plants they have gnawed for the cattle often die that afterwards feed in the places where they passed.

As to the rest the male is larger and more beautifully spotted than the female. They are extremely prolific and, what is extraordinary their breeding does not hinder their march for some of them have been observed to carry one young one in their mouth and another on their back. They are greatly preyed upon by the ermine and as we are told even by the rein deer. The Swedes and Norwegians who live by husbandry consider an invasion from these vermin as a terrible visitation but it is very different with respect to the Lapplanders who lead a vagrant life and who like the lemmings themselves if their provisions be destroyed in one part of the country can easily retire to another. These are never so happy as when an army of lemmings come down amongst them for then they feast upon their flesh which though horrid food and which though even dogs and cats are known to detest these little savages esteem very good eating and devour greedily. They are glad of their arrival also upon another account for they always expect a great plenty of game the year following among those fields which the lemmings have destroyed.

THE MOLE

To these minute animals of the rat kind a great part of whose lives is past in holes under ground I will subjoin one little animal more no way resembling the rat except that its whole life is spent there. As we have seen some

quadrupeds formed to crop the surface of the fields, and others to live upon the tops of trees, so the mole is formed to live wholly under the earth, as if nature meant that no place should be left wholly untenanted. Were we from our own sensations to pronounce upon the life of a quadruped that was never to appear above ground, but always condemned to hunt for its prey underneath, obliged, whenever it removed from one place to another, to bore its way through a resisting body, we should be apt to assert that such an existence must be the most frightful and solitary in nature. However, in the present animal, though we find it condemned to all those seeming inconveniences, we shall discover no signs of wretchedness or distress. No quadruped is fatter, none has a more sleek or glossy skin, and, though denied many advantages that most animals enjoy, it is more liberally possessed of others, which they have in a more scanty proportion.

This animal, so well known in England, is, however, utterly a stranger in other places, and particularly in Ireland. For such, therefore, as have never seen it, a short description will be necessary. And, in the first place, though somewhat of a size between the rat and the mouse, it no way resembles either, being an animal entirely of a singular kind, and perfectly unlike any other quadruped whatever. It is bigger than a mouse, with a coat of fine, short, glossy, black hair. Its nose is long and pointed, resembling that of a hog, but much longer. Its eyes are so small, that it is scarcely possible to discern them. Instead of ears, it has only holes in the place. Its neck is so short that the head seems stuck upon the shoulders. The body is thick and round, terminating by a very small short tail, and its legs also are so very short, that the animal seems to lie flat on its belly. From under its belly, as it rests in this position, the four feet appear just as if they immediately grew out of the body. Thus the animal appears to us at first view as a mass of flesh covered with a fine, shining, black skin, with a little head, and scarcely any legs, eyes, or tail. On a closer inspection, however, two little black points may be discerned, that are its eyes. The ancients, and some of the moderns, were of opinion that the animal was utterly blind, but Derham, by the help of a microscope, plainly discovered all the parts of the eye that are known in other animals, as the

pupil the vitreous and crystalline humours The fore legs appear very short and strong and furnished with five claws to each These are turned outwards and backwards as the hands of a man when swimming The hind legs are longer and weaker than the fore being only used to assist its motions whereas the others are continually employed in digging The teeth are like those of a shrew mouse and there are five on both sides of the upper jaw which stand out but those behind are divided into points The tongue is as large as the mouth will hold

Such is the extraordinary figure and formation of this animal which if we compare with its manner of living we shall find a manifest attention in nature to adapt the one to the other * As it is allotted a subterraneous abode the seeming defects of its formation vanish or rather are turned to its advantage The breadth strength and shortness of the fore feet which are inclined outwards answer the purposes of digging serving to throw back the earth with greater ease and to pursue the worms and insects which are its prey had they been longer the falling in of the earth would have prevented the quick repetition of its strokes in working or have obliged it to make a larger hole in order to give room for their exertion The form of the body is not less admirably contrived for its way of life The fore part is thick and very muscular giving great strength to the action of the fore feet enabling it to dig its way with amazing force and rapidity either to pursue its prey or elude the search of the most active enemy By its power of boring the earth it quickly gets below the surface and I have seen it when let loose in the midst of a field like the ghost on a theatre instantly sink into the earth and the most active labourer with a spade in vain attempted to pursue

The smallness of its eyes which induced the ancients to think it was blind is to this animal a peculiar advantage A small degree of vision is sufficient for a creature that is ever destined to live in darkness A more extensive sight would only have served to shew the horrors of its prison while nature had denied it the means of an escape Had this organ been larger it would have been perpetually liable to injuries by the falling of the earth into it but nature to

* British Z. ol. 6v

prevent that inconvenience, has not only made them very small, but very closely covered them with hair. Anatomists mention, besides these advantages, another that contributes to their security, namely, a certain muscle, by which the animal can draw back the eye whenever it is necessary or in danger.

As the eye is thus perfectly fitted to the animal's situation, so also are the senses of hearing and smelling. The first gives it notice of the most distant appearance of danger, the other directs it, in the midst of darkness, to its food. The wants of a subterraneous animal can be but few, and these are sufficient to supply them to eat, and to produce its kind, are the whole employment of such a life, and for both these purposes it is wonderfully adapted by nature.*

Thus admirably is this animal fitted for a life of darkness and solitude; with no appetites but what it can easily indulge, with no enemies but what it can easily evade or conquer. As soon as it has once buried itself in the earth, it seldom stirs out unless forced by violent rains in summer; or, when in pursuit of its prey, it happens to come too near the surface, and thus gets into the open air, which may be considered as its unnatural element. In general, it chooses the looser, softer grounds, beneath which it can travel with greater ease, in such also it generally finds the greatest number of worms and insects, upon which it chiefly preys. It is observed to be most active, and to cast up most earth, immediately before rain, and, in winter, before a thaw, at those times the worms and insects begin to be in motion, and approach the surface, whither this industrious animal pursues them. On the contrary, in very dry weather, the mole seldom or never forms any hillocks, for then it is obliged to penetrate deeper after its prey, which at such seasons retire far into the ground.

As the moles very seldom come above ground, they

* Testes habet maximos, parastatas amplissimas, novum corpus seminale ab his diversum ac separatum. Penem etiam facile omnium, ni fallor, animalium longissimum, ex quibus colligere est maximam præ reliquis omnibus animalibus voluptatem in coitu, hoc abjectum et vile animalculum percipere, ut habeant quod ipsi invident qui in hoc supremas vitæ suæ delicias collocant. Ray's Synops Quadrup p 239. Huic opinioni assentitur D Buffon, attamen non mihi apparet magnitudinem partium talem voluptatem augere. Maribus enim salacissimis contrarium obtinet.

have but few enemies and very readily evade the pursuit of animals stronger and swifter than themselves *. Their greatest calamity is an inundation which wherever it happens they are seen in numbers attempting to save themselves by swimming and using every effort to reach the higher grounds. The greatest part however perish as well as their young which remain in the holes behind. Were it not for such accidents from their great fecundity they would become extremely troublesome and as it is in some places they are considered by the farmer as his greatest pest. They couple towards the approach of spring and their young are found about the beginning of May. They generally have four or five at a time and it is easy to distinguish among other mole hills that in which the female has brought forth her young. These are made with much greater art than the rest and are usually larger. The female in order to form this retreat begins by erecting the earth into a tolerably spacious apartment which is supported within by partitions at proper distances that prevent the roof from falling. All round this she works and beats the earth very firm so as to make it capable of keeping out the rain let it be never so violent. As the hillock in which this apartment is thus formed is raised above ground the apartment itself is consequently above the level of the plain and therefore less subject to accidental slight inundations. The place being thus fitted she then procures grass and dry leaves as a bed for her young. There they lie secure from wet and she continues to make their retreat equally so from danger for all round this hill of her own raising are holes running into the earth that part from the middle apartment like rays from a centre and extend about fifteen feet in every direction these resemble so many walks or chases into which the animal makes her subterraneous excursions and supplies her young with such roots or insects as she can provide but they contribute still more to the general safety for as the mole is very quick of hearing the instant she perceives her little habitation attacked she takes to her burrow and unless the earth be dug away by several men at once she and her young always make a good retreat.

The mole is scarcely found, except in cultivated countries : the varieties are but few That which is found in Virginia, resembles the common mole, except in colour, which is black, mixed with a deep purple There are sometimes white moles, seen particularly in Poland, rather larger than the former As their skin is so very soft and beautiful, it is odd that it has not been turned to any advantage Agricola tells us, that he saw hats made from it, the finest and the most beautiful that could be imagined

CHAP II

THE HEDGEHOG, OR PRICKLY KIND.

ANIMALS of the Hedgehog kind require but very little accuracy to distinguish them from all others That hair which serves the generality of quadrupeds for warmth and ornament, is partly wanting in these, while its place is supplied by sharp spines or prickles, that serve for their defence This general characteristic, therefore, makes a much more obvious distinction than any that can be taken from their teeth or their claws Nature, by this extraordinary peculiarity, seems to have separated them in a very distinguished manner, so that, instead of classing the hedgehog among the moles, or the porcupine with the hare, as some have done, it is much more natural and obvious to place them, and others approaching them in this strange peculiarity, in a class by themselves nor let it be supposed, that while I thus alter their arrangement, and separate them from animals with which they have been formerly combined, that I am destroying any secret affinities that exist in nature It is natural, indeed, for readers to suppose, when they see two such opposite animals as the hare and the porcupine assembled together in the same group, that there must be some material reason, some secret connection, for thus joining animals so little resembling each other in appearance But the reasons for this union were very slight, and merely arose from a similitude in the fore-teeth no likeness in the internal conformation, no similitude in nature, in habitudes, or disposition, in short, nothing to fasten the link that combines them, but the similitude in the teeth this, therefore, may be easily dispensed with; and, as was said, it will be

most proper to class them according to their most striking similitudes

The hedgehog with an appearance the most formidable is yet one of the most harmless animals in the world unable or unwilling to offend all its precautions are only directed to its own security and it is armed with a thousand points to keep off the enemy but not to invade him While other creatures trust to their force their cunning or their swiftness this animal destitute of all but one expedient for safety and from this alone it often finds protection As soon as it perceives itself attacked it withdraws all its vulnerable parts rolls itself into a ball and presents nothing but its defensive thorns to the enemy, thus while it attempts to injure no other quadruped they are equally incapable of injuring it like those knights we have somewhere read of who were armed in such a manner that they could neither conquer others nor be themselves overcome

This animal is of two kinds one with a nose like the snout of a hog the other more short and blunt like that of a dog That with the muzzle of a dog is the most common being about six inches in length from the tip of the nose to the insertion of the tail The tail is little more than an inch long and so concealed by the spines as to be scarcely visible the head back and sides are covered with prickles the nose breast and belly are covered with fine soft hair * the legs are short of a dusky colour and almost bare the toes on each foot are five in number long and separated the prickles are about an inch in length and very sharp pointed their lower part is white the middle black and the points white the eyes are small and placed high in the head the ears are round pretty large and naked the mouth is small but well furnished with teeth these however it only uses in chewing its food but neither in attacking or defending itself against other animals Its only reliance in cases of danger is on its spines the instant it perceives an enemy it puts itself into a posture of defence and keeps upon its guard until it supposes the danger over On such occasions it immediately alters its whole appearance from its usual form

* Præput um propend ns L nnaei Syst
might have said resupina copulatur

And of the female he

somewhat resembling a small animal, with a bunch on its back, the animal begins to bend its back, to lay its head upon its breast, to shut its eyes, to roll down the skin of its sides towards the legs, to draw these up, and lastly, to tuck them in on every side, by drawing the skin still closer. In this form, which the hedgehog always puts on when disturbed it no way resembles an animal, but rather a roundish mass of prickles, impervious on every side. The shape of the animal thus rolled up, somewhat resembles a chestnut in the husk, there being, on one side, a kind of flat space, which is that on which the head and legs have been tucked in.

Such is the usual appearance of the hedgehog, upon the approach of any danger. Thus rolled up in a lump, it patiently waits till its enemy passes by, or is fatigued with fruitless attempts to annoy it. The cat, the weasel, the ferret, and the martin, quickly decline the combat, and the dog himself generally spends his time in empty menaces, rather than in effectual efforts. Every increase of danger only increases the animal's precautions to keep on its guard, its assailant vainly attempts to bite, since he thus more frequently feels than inflicts a wound, he stands enraged and barking, and rolls it along with his paws still, however, the hedgehog patiently submits to every indignity, but continues secure; and still more to disgust its enemy with the contest, sheds its urine, the smell of which is alone sufficient to send him away. In this manner the dog, after barking for some time, leaves the hedgehog where he found him, who, perceiving the danger past, at length peeps out from its ball, and, if not interrupted, creeps slowly to its retreat.

The hedgehog, like most other wild animals, sleeps by day, and ventures out by night. It generally resides in small thickets, in hedges, or in ditches covered with bushes: there it makes a hole of about six or eight inches deep, and lies well wrapped up, in moss, grass, or leaves. Its food is roots, fruits, worms, and insects. It is also said to suck cattle, and hunt their udders, but the smallness of its mouth will serve to clear it from this reproach. It is said also to be very hurtful in gardens and orchards, where it will roll itself in a heap of fruit, and so carry a large quantity away upon its prickles, but this imputation is as

ill grounded as the former since the spines are so disposed that no fruit will stick upon them even if we should try to fix them on. It rather appears to be a very serviceable animal in ridding our fields of insects and worms which are so prejudicial to vegetation.

Mr Buffon who kept these animals time about his house acquits them of the reproach of being mischievous in the garden but then he accuses them of tricks of which from the form and habits of this animal one would never be led to suspect them. I have often says he

had the female and her young brought me about the beginning of June they are generally from three to five in number they are white in the beginning and only the marks of their spines appear. I was willing to rear some of them and accordingly put the dam and her young into a tub with abundant provision beside them but the old animal instead of suckling her young devoured them all one after another. On another occasion an hedgehog that had made its way into the kitchen discovered a little pot in which there was meat prepared for boiling the mischievous animal drew out the meat and left its excrement in the stead. I kept males and females in the same apartment where they lived together but never coupled. I permitted several of them to go about my garden they did very little damage and it was scarcely perceivable that they were there they lived upon the fruits that fall from the trees they dug the earth into shallow holes they eat caterpillars beetles and worms they were also very fond of flesh which they devoured boiled or raw.

They couple in spring and bring forth about the beginning of summer. They sleep during the winter and what is said of their laying up provisions for that season is consequently false. They at no time eat much and can remain very long without any food whatsoever. Their blood is cold like all other animals that sleep during the winter. Their flesh is not good for food and their skins are converted to scarcely any use except to muzzle calves to keep them from sucking.

THE TANPEC AND TENDRAC

THE Tanree and Tendrac are two little animals described by Mr Buffon of the hedgehog kind but yet sufficiently

different from it to constitute a different species. Like the hedgehog, they are covered with prickles, though mixed in a greater proportion with hair, but, unlike that animal, they do not defend themselves by rolling up in a ball. Then wanting this last property is alone sufficient to distinguish them from an animal in which it makes the most striking peculiarity, as also that in the East Indies, where only they are found, the hedgehog exists separately also, a manifest proof that this animal is not a variety caused by the climate.

The Tanrec is much less than the hedgehog,* being about the size of a mole, and covered with prickles, like that animal, except that they are shorter and smaller. The Tendiac is still less than the former, and is defended only with prickles upon the head, the neck, and the shoulders; the rest being covered with a coarse hair, resembling a hog's bristles. These little animals, whose legs are very short, move but slowly. They grunt like a hog, and wallow, like it, in the mire. They love to be near water, and spend more of their time there than upon land. They are chiefly in creeks and harbours of salt water. They multiply in great numbers, make themselves holes in the ground, and sleep for several months. During this torpid state, their hairs (and I should also suppose their prickles) fall; and they are renewed upon their revival. They are usually very fat, and although their flesh be insipid, soft, and stringy, yet the Indians find it to their taste, and consider it as a very great delicacy.

THE PORCUPINE

THOSE arms which the hedgehog possesses in miniature, the Porcupine has in a more enlarged degree. The short prickles of the hedgehog are, in this animal, converted into shafts. In the one, the spines are about an inch long; in the other, a foot. The porcupine is about two feet long, and fifteen inches high. Like the hedgehog, it appears a mass of misshapen flesh, covered with quills, from ten to fourteen inches long, resembling the barrel of a goose-quill in thickness, but tapering and sharp at both ends. These, whether considered separately or together, afford sufficient subject to detain curiosity. Each quill is thickest in the

* Buffon, vol. xlv p. 254

middle and inserted into the animal's skin in the same manner as feathers are found to grow upon birds. It is within and spongy like the top of a goose quill and of different colours being white and black alternately from one end to the other. The biggest are often found fifteen inches long and a quarter of an inch in diameter extremely sharp and capable of inflicting a mortal wound. They seem harder than common quills being difficult to be cut and solid at that end which is not fixed in the skin. If we examine them in common as they grow upon the animal they appear of two kinds the one such as I have already described the other long flexible and slender growing here and there among the former. There is still another sort of quills that grow near the tail white and transparent like writing quills and that seem to be cut short at the end. All these quills of whatever kind incline backwards like the bristles of a hog but when the animal is irritated they rise and stand upright as bristles are seen to do *

Such is the formation of this quadruped in those parts in which it differs from most others as to the rest of its figure the muzzle bears some resemblance to that of a hare but black the legs are very short and the feet have five toes both before and behind and these as well as the belly the head and all other parts of the body are covered with a sort of short hair like prickles there being no part except the ears and the sole of the foot that is free from them the ears are thinly covered with very fine hair and are in shape like those of mankind the eyes are small like those of a hog being only one third of an inch from one corner to the other. After the skin is taken off there appear a kind of paps on those parts of the body from whence the large quills proceed these are about the size of a small pebble answering to as many holes which appear on the outward surface of the skin and which are about half an inch deep like as many hollow pipes wherein the quills are fixed as in so many sheaths.

Professor Thunberg in his second journey to the Indian Empire in the Indian Ocean informs us that the porcupine has a very curious method of feeding water for its young. The quills in the tail are all to be hollow and to break all at the extremity the ethanmian benin such a manner that they can be filled with water which is afterwards discharged in the nest among its young.

This animal seems to partake very much of the nature of the hedgehog, having this formidable apparatus of arms rather to defend itself, than annoy the enemy. There have been, indeed, many naturalists who supposed that it was capable of discharging them at its foes, and killing at a great distance off. But this opinion has been entirely discredited of late, and it is now universally believed that its quills remain firmly fixed in the skin, and are then only shed when the animal moults them, as birds do their feathers. It is true, we are told by Ellis, that a wolf at Hudson's Bay was found dead, with the quills of a porcupine fixed within its mouth, which might have very well happened, from the voraciousness of the former, and not the resentment of the latter. That rapacious creature, in the rage of appetite, might have attempted to devour the porcupine, quills and all, and very probably paid the forfeit by its life. However this be, of all the porcupines that have been brought into Europe, not one was ever seen to launch their quills, and yet the irritations they received were sufficient to have provoked their utmost indignation. Of all the porcupines that Dr Shaw observed in Africa, and he saw numbers, not one ever attempted to dart its quills, their usual manner of defence being, to lie on one side, and when the enemy approaches very near, by suddenly rising, to wound him with the points on the other.*

It is probable, therefore, that the porcupine is seldom the aggressor, and when attacked by the bolder animals, it only directs its quills so as to keep always pointing towards the enemy. These are an ample protection, and, as we are assured by Kolben, at such times even the lion himself will not venture to make an attack. From such, therefore, the porcupine can defend itself, and chiefly hunts for serpents, and all other reptiles, for subsistence. Travellers universally assure us, that between the serpent and the porcupine there exists an unconcileable enmity, and that they never meet without a mortal engagement.† The porcupine, on these occasions, is said to roll itself upon the serpent, and thus destroy and devour it. This

* M de Vaillant in his Travels says, that owing to some pernicious quality in the quills, one of his Hottentots, who had received a wound in his leg from a porcupine, was ill for more than six months.

† Bosman Smith L P Vincent Marie, &c

may be true while what we are informed by Monsieur Surrisin of the porcupine of Canada chiefly subsisting on vegetables may be equally so. Those which are brought to this country to be shown are usually fed on bread milk and fruits but they will not refuse meat when it is offered them and it is probable they prefer it in a wild state when it is to be had *. The porcupine is also known to be extremely hurtful to gardens and where it enters does incredible damage.

The Americans who hunt this animal assure us that the porcupine lives from twelve to fifteen years. During the time of coupling which is in the month of September the males become very fierce and dangerous and often are seen to destroy each other with their teeth. The female goes with young seven months and brings forth but one at a time this she suckles but about a month and afterwards it betimes to live like herself upon vegetables and the bark of trees she is very fierce in its defence but at other seasons she is fearful timid and harmless. The porcupine never attempts to bite nor any way to injure its pursuers if hunted by a dog or a wolf it instantly climbs up a tree and continues there until it has wearied out the patience of its adversary the wolf knows by experience how fruitless it would be to wait he therefore leaves the porcupine above and seeks out for a new adventure. The porcupine does not escape so well from the Indian hunter who eagerly pursues it in order to make embroidery of its quills and to eat its flesh. This as we are commonly told is very tolerable eating however we may expect wretched provisions when the savages are to be our eaters for they eat every thing that has life. But they are very ingenious with regard to their embroidery if I understand the accounts rightly they dye the quills of various colours and then splitting them into slips as we see in the making of a cane chair they embroider with these their belts bracelets and several other necessary pieces of furniture.

As to the rest there are many things related concerning this animal that are fabulous but there are still many circumstances more that yet remain to be known. It were curious to inquire whether this animal moults its quills

when wild, for it is never seen to shed them in a domestic state; whether it sleeps all the winter, as we are told by some naturalists, which we are sure it does not when brought into our country, and, lastly, whether its quills can be sent off with a shake; for no less a naturalist than Reaumer was of that opinion *

All that we can learn of an animal exposed as a show, or even by its dissection, is but merely its conformation; and that makes one of the least interesting parts of its history. We are naturally led, when presented with an extraordinary creature, to expect something extraordinary in its way of living, something uncommon, and corresponding with its figure; but of this animal we know little with any precision, except what it offers in a state of captivity. In such a situation, that which I saw appeared to very little advantage it was extremely dull and torpid, though very wakeful and extremely voracious, though very capable of sustaining hunger, as averse to any attachment, as to being tamed it was kept in an iron cage, and the touching one of the bars was sufficient to excite its resentment, for its quills were instantly erected, and the poet was right in his epithet of *fiery*; for it appeared to me the most irascible creature upon earth.

The porcupines of America differ very much from that of the ancient continent, which we have been describing, and, strictly speaking, may be considered as animals of a different species: however, from their being covered with quills, we will only add them as varieties of the former, since we know very little concerning them, except their difference of figure. They are of two kinds, the one called the *couando*, and the other, first named by Mr. Buffon, the *inson*, the one a native of the northern parts of America; the other of the south; and both differing from the former, in having long tails, whereas that has a very short one

* Mr. Bewick, in his history of this quadruped, says, that upon the smallest irritation it raises its quills, and shakes them with great violence, directing them to that quarter from whence it is in danger of being attacked, and striking at the object of its resentment at the same time. "We have observed, on an occasion of this sort, at a time when the animal was moulting or casting its quills, that they would fly out to the distance of a few yards, with such force as to bend the points of them against the board where they struck, and it is not improbable that a circumstance of this kind may have given rise to an opinion of its power to use them in a more effectual manner."

THE COVANDO is much less than the porcupine its quills are four times shorter its snout more unlike that of a hare its tail is long enough to catch by the branches of trees and hold by them It may be easily tamed and it is to be found chiefly in the southern parts of America yet is not wanting also in the northern

The URSON which Mr Buffon calls after our countryman Hudson is a native of Hudson's Bay The make of the body of this animal is not so round as that of the two former but somewhat resembling the shape of a pig It is covered with long bristly hair with a shorter hair underneath and under this the quills lie concealed very thick they are white with a brown point and bearded and the longest do not exceed four inches they stick to the hand when the animal is stroked on the back and likewise when the hand is taken away they stick so fast as to follow it They make their nest under the roots of great trees sleep very much and chiefly feed upon the bark of the juniper In winter the snow serves them for drink and in summer they lap water like a dog They are very common in the country lying to the east of Hudson's Bay and several of the trading Americans depend on them for food at some seasons of the year

CHAP III

OF QUADRUPEDS COVERED WITH SCALES OR SHELLS IN STEAD OF HAIR *

WHEN we talk of a quadruped the name seems to imply an animal covered with hair when we mention a bird it is natural to conceive a creature covered with feathers when we hear of a fish its scales are generally the first part that strikes our imagination Nature however owns none of our distinctions various in all her operations she mixes her plans groups her pictures and excites our wonder as well by her general laws as by her deviations Quadrupeds which we have considered as making the first general class in animated nature and next to man the most dignified tenants of the earth are yet in many respects related to the classes beneath them and do not in every respect

* This chapter is chiefly extracted from Mr Buffon which I ment on at once to save the trouble of repeated quotation

preserve then usual distinctions Their first character, which consists in having four feet, is common to the lizard kind as well as to them The second prerogative, which is that of bringing forth living young, is found in the cetaceous tribe of fishes, and also in insects without number Their third and last attribute, which seems more general and constant than the former, that of being covered with hair, is yet found in various other animals, and is deficient in quadrupeds themselves Thus we must be cautious of judging of the nature of animals from one single character, which is always found incomplete, for it often happens that three or four of the most general characters will not suffice It must be by a general enumeration of the parts that we can determine precisely of the works of the creation; and instead of definitions, learn to describe Had this method been followed, much of the disgust and the intricacy of history might have been avoided, and that time, which is now employed in combating error, laid out in the promoting of science

Were we to judge of nature from definitions only, we should never be induced to suppose that there existed races of viviparous quadrupeds destitute of hair, and furnished with scales and shells in their stead However, nature, every way various, supplies us with many instances of these extraordinary creatures, the old world has its quadrupeds covered with scales, and the new with a shell In both, they resemble each other, as well in the strangeness of their appetites, as in their awkward conformation Like animals but partially made up, and partaking of different natures, they want those instincts which animals, formed but for one element alone, are found to possess They seem to be a kind of strangers in nature, creatures taken from some other element, and capriciously thrown to find a precarious subsistence upon land.

THE PANGOLIN.

THE Pangolin, which has been usually called the *scaly lizard*, Mr Buffon very judiciously restores to that denomination by which it is known in the countries where it is found The calling it a lizard, he justly observes, might be apt to produce error, and occasion its being confounded with an animal which it resembles only in its general form

and in its being covered with scales. The lizard may be considered as a reptile produced from an egg. the pangolin is a quadruped and brought forth alive and perfectly formed. The lizard is all over covered with the marks of scales. the pangolin has scales neither on the throat the breast nor the belly. The scales of the lizard seem stuck upon the body even closer than those of fishes. the scales of the pangolin are only fixed at one end and capable of being erected like those of the porcupine at the will of the animal. The lizard is a defenceless creature. the pangolin, can roll itself into a ball like the hedgehog and present the points of its scales to the enemy which effectually defend it.

The pangolin which is a native of the torrid climates of the ancient continent is of all other animals the best protected from external injury by nature. It is about three or four feet long or taking in the tail from six to eight. Like the lizard it has a small head a very long nose a short thick neck a long body legs very short and a tail extremely long thick at the insertion and terminating in a point. It has no teeth but is armed with five toes on each foot with long white claws. But what it is chiefly distinguished by is its scaly covering which in some measure hides all the proportions of its body. These scales defend the animal on all parts except the under part of the head and neck under the shoulders the breast the belly and the inner side of the legs all which parts are covered with a smooth soft skin without hair. Between the shells of this animal at all the interstices are seen hairs like bristles brown at the extremity and yellow towards the root. The scales of this extraordinary creature are of different sizes and different forms and stuck upon the body somewhat like the leaves of an artichoke. The largest are found near the tail which is covered with them like the rest of the body. These are above three inches broad and about two inches long thick in the middle and sharp at the edges and terminated in a roundish point. They are extremely hard and their substance resembles that of horn. They are convex on the outside and a little concave on the inner one edge sticks in the skin while the other laps over that immediately behind it. Those that cover the tail conform to the shape of that part being of a dusky brown colour,

and so hard, when the animal has acquired its full growth, as to turn a musket-ball

Thus armed, this animal fears nothing from the efforts of all other creatures, except man. The instant it perceives the approach of an enemy, it rolls itself up like the hedgehog, and presents no part but the cutting edges of its scales to the assailant. Its long tail, which, at first view, might be thought easily separable, serves still more to increase the animal's security. This is lapped round the rest of the body, and, being defended with shells even more cutting than any other part, the creature continues in perfect security. Its shells are so large, so thick, and so pointed, that they repel every animal of prey, they make a coat of armour that wounds while it resists, and at once protects and threatens. The most cruel, the most famished quadruped of the forest, the tiger, the panther, and the hyæna, make vain attempts to force it. They tread upon, they roll it about, but all to no purpose, the pangolin remains safe within, while its invader almost always feels the reward of its rashness. The fox often destroys the hedgehog by pressing it with his weight, and thus obliges it to put forth its nose, which he instantly seizes, and soon after the whole body, but the scales of the pangolin effectually support it under any such weight, while nothing that the strongest animals are capable of doing can compel it to surrender. Man alone seems furnished with arms to conquer its obstinacy. The negroes of Africa, when they find it beat it to death with clubs, and consider its flesh as a very great delicacy.

But although this animal be so formidable in its appearance, there cannot be a more harmless inoffensive creature when unmolested. It is even unqualified by nature to injure larger animals, if it had the disposition, for it has no teeth. It should seem that the bony matter, which goes in other animals to supply the teeth, is exhausted in this in supplying the scales that go to the covering of its body. However this be, its life seems correspondent to its peculiar conformation. Incapable of being carnivorous, since it has no teeth, nor of subsisting on vegetables, which require much chewing, it lives entirely upon insects, for which nature has fitted it in a very extraordinary manner. As it has a long nose, so it may naturally be supposed to have a long tongue; but, to increase its length still more, it is doubled in the

mouth so that when extended it is shot out to above a quarter of a yard beyond the tip of the nose. This tongue is round extremely red and covered with an unctuous and slimy liquor which gives it a shining hue. When the pangolin therefore approaches an ant hill, for the care the insects on which it chiefly feeds it lies down near it concealing as much as possible the place of its retreat and stretching out its long tongue among the ants keeps it for some time quite immovable. These little animals allured by its appearance and the unctuous substance with which it is smeared inantly gather upon it in great numbers and when the pangolin supposes a sufficiency it quickly withdraws the tongue and swallows them at once. This peculiar manner of hunting for its prey is repeated either till it be satisfied or till the ants grown more cautious will be allured to their destruction no longer. It is against these noxious insects therefore that its only force or cunning is exerted and were the negroes but sufficiently sensible of its utility in destroying one of the greatest pests to their country they would not be so eager to kill it. But it is the nature of savage men to pursue the immediate good without being solicitous about the more distant benefit they remove. They therefore hunt this animal with the utmost avidity for its flesh, and as it is slow and unable to escape in an open place they seldom fail of destroying it. However it chiefly keeps in the most obscure parts of the forest and digs itself a retreat in the clefts of rocks where it brings forth its young so that it is but rarely met with and continues a solitary species and an extraordinary instance of the varying of nature.

Of this animal there is a variety which is called the *PIG RATA* much less than the former being not above a foot long from the head to the tail with shells differently formed with its belly breast and throat covered with hair instead of a smooth skin as in the former but that by which it is peculiarly distinguished is the extent of its tail which is above twice the length of its body. Both are found in the warm latitudes of the East as well as in Africa and as their numbers are but few it is to be supposed their fecundity is not great.

THE ARMADILLO, OR TATOU.

HAVING mentioned quadrupeds of the ancient continent covered with scales, we come next to quadrupeds of the new continent covered with shells. It would seem that Nature had reserved all the wonders of her power for these remote and thinly inhabited countries, where the men are savage, and the quadrupeds various. It would seem that she becomes more extraordinary in proportion as she retires from human inspection. But the real fact is, that wherever mankind are polished, or thickly planted, they soon rid the earth of these odd and half-formed productions, that in some measure encumber the soil. They soon disappear in a cultivated country, and continue to exist only in those remote deserts where they have no enemies but such as they are enabled to oppose.

The Armadillo is chiefly an inhabitant of South America; a peaceful, harmless creature, incapable of offending any other quadruped, and furnished with a peculiar covering for its own defence. The pangolin, described above, seems an inactive, helpless being, indebted for safety more to its patience than its power, but the armadillo is still more exposed and helpless. The pangolin is furnished with an armour that wounds while it resists, and that is never attacked with impunity, but the armadillo is obliged to submit to every insult, without any power of repelling its enemy, it is attacked without danger, and is consequently liable to more various persecutions.

This animal being covered, like a tortoise, with a shell, or rather a number of shells, its other proportions are not easily discerned. It appears, at first view, a round misshapen mass, with a long head, and a very large tail sticking out at either end, as if not of a piece with the rest of the body. It is of different sizes, from a foot to three feet long, and covered with a shell divided into several pieces, that lap over each other like the plaits in a coat of armour, or in the tail of a lobster. The difference in the size of this animal, and also the different disposition and number of its plaits, have been considered as constituting so many species, each marked with its own particular name. In all, however, the animal is partially covered with this natural

coat of mail the conformation of which affords one of the most striking curiosities in natural history. This shell which in every respect resembles a bony substance covers the head the neck the back the sides the rump and the tail to the very point. The only parts to which it does not extend are the throat the breast and the belly which are covered with a white soft skin somewhat resembling that of a fowl stripped of its feathers. If these naked parts be observed with attention they will be found covered with the rudiments of shells of the same substance with those which cover the back. The skin even in the parts which are softest seems to have a tendency to ossify but a complete ossification takes place only on those parts which have the least friction and are the most exposed to the weather. The shell which covers the upper part of the body differs from that of the tortoise in being composed of more pieces than one which lie in bands over the body, and as in the tail of the lobster slide over each other and are connected by a yellow membrane in the same manner. By this means the animal has a motion in its back and the armour gives way to its necessary inflexions. These bands are of various numbers and sizes and from them these animals have been distinguished into various kinds. In general however there are two large pieces that cover one the shoulders and the other the rump. In the back between these the bands are placed in different numbers that lap over each other and give ply to the whole. Besides their opening cross ways they also open down along the back so that the animal can move in every direction. In some there are but three of these bands between the large pieces in others there are six in a third kind there are eight in a fourth kind nine in a fifth kind twelve and lastly in the sixth kind there is but one large piece which covers the shoulders and the rest of the body is covered with bands all down to the tail. These shells are differently coloured in different kinds but most usually they are of a dirty grey. This colour in all arises from another peculiar circumstance in their conformation for the shell itself is covered with a softish skin which is smooth and transparent.

But although these shells might easily defend this animal from a feeble enemy yet they could make but a slight

resistance against a more powerful antagonist ; nature, therefore, has given the armadillo the same method of protecting itself with the hedgehog or the pangolin. The instant it perceives itself attacked, it withdraws the head under its shells, and lets nothing be seen but the tip of the nose. If the danger increases, the animal's precautions increase in proportion, it then tucks up its feet under its belly, unites its two extremities together, while the tail seems as a band to strengthen the connection ; and it thus becomes like a ball, a little flattish on each side. In this position it continues obstinately fixed, while the danger is near, and often long after it is over. In this situation it is tossed about at the pleasure of every other quadruped, and very little resembling a creature endowed with life and motion. Whenever the Indians take it, which is in this form, by laying it close to the fire, they soon oblige the poor animal to unfold itself, and to face a milder death to escape a more severe.

This animal is a native only of America, for they were utterly unknown before the discovery of that continent. It is an inoffensive harmless creature, unless it finds the way into a garden, where it does a great deal of mischief, by eating the melons, the potatoes, and other vegetables. Although a native of the warmest parts of America, yet it bears the cold of our climate without any inconvenience. We have often seen them shewn among other wild beasts, which is a proof they are not difficult to be brought over. Their motion seems to be a swift walk, but they can neither run, leap, nor climb trees ; so that, if found in an open place, they have no method of escaping from their pursuers. Their only resource in such an extremity is to make towards their hole as fast as they can, or, if this be impracticable, to make a new hole before the enemy arrives. For this they require but a very few moments advantage, the mole itself does not burrow swifter than they can. For this purpose, they are furnished with claws extremely large, strong, and crooked, and usually four upon each foot. They are sometimes caught by the tail as they are making their way into the earth, but such is their resistance, and so difficult is it to draw them backward, that they leave their tail in the hand of their pursuer, and are very well contented to save their lives with its loss. The pursuers, sensible of this,

never drag the tul with all their force but hold it while another digs the ground about them and thus these animals are taken alive. The instant the armadillo perceives itself in the power of its enemies it has but one last resource to roll itself up and thus patiently wait whatever tortures they think proper to inflict. The flesh of the smaller kinds is said to be delicate eating so that we may suppose they receive no mercy. For this reason they are pursued with unceasing industry and although they burrow very deep in the earth there have been many expedients used to force them out. The hunter sometimes contrive to fill the hole with smoke which is often successful they at other times force it by pouring in water. They also bring up a small kind of dogs to the chase that quickly overtake them if at any distance from their burrow and oblige them to roll themselves up in a ball in which figure the hunters carry them home. If however the armadillo be near a precipice it often escapes by rolling itself up and then tumbling down from rock to rock without the least danger or inconvenience. They are sometimes taken in snares laid for them by the sides of rivers and low moist places which they particularly frequent and this method in general succeeds better than any of the former as their burrows are very deep and they seldom stir out except in the night. At no time are they found at any great distance from their retreats so that it requires some patience and skill to intercept their retreat.

There are scarcely any of these that do not root the ground like a hog in search of such roots as make a principal part of their food. They live also upon melons and other succulent vegetables and will eat flesh when they can get it. They frequent water and watery places where they feed upon worms small fish and water insects. It is pretended that there is a kind of friendship between them and the rattle snake that they live peaceably and communally together and are frequently found in the same hole. This however may be a friendship of necessity to the armadillo the rattle snake takes possession of its retreats which neither are willing to quit while each is incapable of injuring the other.

As to the rest these animals though they all resemble each other in the general character of being clothed with

a shell, yet differ a good deal in their size, and in the parts into which their shell is divided. The first of this kind, which has but three bands between the two large pieces that cover the back, is called the *TATU APARA*. I will not enter into an exact description of its figure, which, how well written soever, no imagination could exactly conceive; and the reader would be more fatigued to understand than I to write it. The tail is shorter in this than any other kind, being not more than two inches long, while the shell, taking all the pieces together, is a foot long and eight inches broad. The second is the *TATOU* of Ray, or the *ENCOUBERT* of Buffon, this is distinguished from the rest by six bands across the back, it is about the size of a pig of a month old, with a small long head and a very long tail. The third is the *TATUETTE*, furnished with eight bands, and not by a great deal so big as the former. Its tail is longer also, and its legs shorter in proportion. Its body, from the nose to the insertion of the tail, is about ten inches long, and the tail seven. The fourth is the *PIG-HEADED ARMADILLO*, with nine bands. This is much larger than the former, being about two feet long from the nose to the tail. The fifth is the *KABASSOU*, or *CATA-PHRACTUS*, with twelve bands, and still bigger than the former, or any other of its kind. This is often found above three feet long, but is never eaten, as the rest are. The sixth is the *WEASEL-HEADED ARMADILLO*, with eighteen bands, with a large piece before, and nothing but bands backward. This is above a foot long, and the tail five inches. Of all these, the *kabassou* and the *encoubert* are the largest, the rest are of a much smaller kind. In the larger kinds, the shell is much more solid than in the others, and the flesh is much harder, and unfit for the table. These are generally seen to reside in dry upland grounds, while the small pieces are always found in moist places, and in the neighbourhood of brooks and rivers. They all roll themselves into a ball, but those whose bands are fewest in number are least capable of covering themselves up completely. The *tatu apara*, for instance, when rolled up, presents two great interstices between its bands, by which it is very easily vulnerable, even by the feeblest of quadrupeds.

CHAP. IV

ANIMALS OF THE BAT KIND

HAVING in the last chapter described a race of animals that unite the boundaries between quadrupeds and insects I come in this to a very different class that serve to fill up the chasm between quadrupeds and birds. Some naturalists indeed have found animals of the bat kind so much partaking of the nature of both that they have been at a loss in which rank to place them and have doubted in giving the history of the bat whether it was a beast or a bird they were describing. These doubts however no longer exist they are now universally made to take their place among quadrupeds to which their bringing forth their young alive their hair their teeth as well as the rest of their habitudes and conformation evidently entitle them. Pliny Gesner and Aldrovandus who placed them among birds did not consider that they wanted every character of that order of animals except the power of flying. Indeed when this animal is seen with an awkward and struggling motion supporting itself in the air at the dusk of the evening it presents in some measure the appearance of a bird but naturalists whose business it is to examine it more closely to watch its habitudes and inspect into its formation are inexcusable for concurring in the mistake.

The bat in scarcely any particular resembles the bird except in its power of sustaining itself in the air. It brings forth its young alive it suckles them its mouth is furnished with teeth its lungs are formed like those of quadrupeds its intestines and its skeleton have a complete resemblance and even are in some measure seen to resemble those of mankind.*

The bat most common in England is about the size of a mouse, or nearly two inches and a half long. The membranes that are usually called wings are properly speaking an extension of the skin all round the body except the head which when the animal flies is kept stretched on every side by the four interior toes of the fore feet which are enormously long and serve like masts that keep the canvass of a sail spread and regulate its motions †. The first toe

* *Ictus propendens*

† British Zoology

is quite loose, and serves as a heel when the bat walks; or as a hook, when it would adhere to any thing. The hind feet are disengaged from the surrounding skin, and divided into five toes, somewhat resembling those of a mouse. The skin by which it flies is of a dusky colour. The body is covered with a short fur, of a mouse colour, tinged with red. The eyes are very small, the ears like those of a mouse.

This species of the bat is very common in England. It makes its first appearance early in summer, and begins its flight in the dusk of the evening. It principally frequents the sides of woods, glades, and shady walks, and is frequently observed to skim along the surface of pieces of water. It pursues gnats, moths, and nocturnal insects of every kind. It feeds upon these; but will not refuse meat, whenever it can find it. Its flight is a laborious irregular movement, and if it happens to be interrupted in its course, it cannot readily prepare for a second elevation, so that if it strikes against any object, and falls to the ground, it is usually taken *. It appears only in the most pleasant evenings, when its prey is generally abroad, and flies in pursuit with its mouth open. At other times it continues in its retreat, the chink of a ruined building, or the hollow of a tree. Thus this little animal, even in summer, sleeps the greater part of its time, never venturing out by day-light, nor in rainy weather, never hunting in quest of prey, but for a small part of the night, and then returning to its hole. But its short life is still more abridged by continuing in a torpid state during the winter. At the approach of the cold season, the bat prepares for its state of lifeless inactivity, and seems rather to choose a place where it may continue safe from interruption, than where it may be warmly or conveniently lodged. For this reason it is usually seen hanging by its hooked claws to the roofs of caves, regardless of the eternal damps that surround it. The bat seems the only animal that will venture to remain in these frightful subterranean abodes, where it continues in a torpid state, unaffected by every change of the weather.

* Mr White, in his natural history of Selbourn, giving an account of a tame bat, says, "I saw it several times confute the vulgar opinion that bats, when down on a flat surface, cannot get on the wing again, by rising with great ease from the floor."

Such of this kind as are not provident enough to procure themselves a deep retreat where the cold and heat seldom vary are sometimes exposed to great inconveniences for the weather often becomes so mild in the midst of winter as to warm them prematurely into life, and to allure them from their hole in quest of food when nature has not provided a supply. These therefore have seldom strength to return but having exhausted themselves in a vain pursuit after insects which are not to be found are destroyed by the owl or any other animal that follows such petty prey.

The bat couples and brings forth in summer generally from two to five at a time of this I am certain that I have found five young ones in a hole together but whether they were the issue of one parent I cannot tell. The female has but two nipples and those forward on the breast as in the human kind. This was a sufficient motive for Linnæus to give it the title of a *primas* to rank it in the same order with mankind and to push this contemptible animal among the chiefs of the creation. Such arbitrary associations produce rather ridicule than instruction and render even method contemptible however we are to forgive too strong an attachment to system in this able naturalist since his application to the particular history of the animal counterbalances the defect.*

From Linnæus we learn that the female makes no nest for her young as most birds and quadrupeds are known to do. She is barely content with the first hole she meets where sticking herself by her hooks against the sides of her apartment she permits her young to hang at the nipple and in this manner to continue for the first or second day. When after some time the dam begins to grow hungry and finds a necessity of stirring abroad she takes her little ones and sticks them to the wall in the manner she before hung herself there they immovably cling and patiently wait till her return.

Thus far this animal seems closely allied to the quadruped race. Its similitude to that of birds is less striking. As nature has furnished birds with extremely strong pectoral muscles to move the wings and direct their flight so has it also furnished this animal. As birds also have their legs weak and unfit for the purposes of motion the bat has its

legs fashioned in the same manner, and is never seen to walk, or, more properly speaking, to push itself forward with its hind legs, but in cases of extreme necessity. The toes of the fore legs, or, if we may use the expression, its extremely long fingers, extend the web like a membrane that lies between them, and this, which is extremely thin, serves to lift the little body into the air. In this manner, by an unceasing percussion, much swifter than that of birds, the animal continues, and directs its flight, however, the great labour required in flying, soon fatigues it, for, unlike birds, which continue for days together upon the wing, the bat is tired in less than an hour, and then returns to its hole, satisfied with its supply, to enjoy the darkness of its retreat.

If we consider the bat as it is seen in our own country, we shall find it a harmless inoffensive creature. It is true that it now and then steals into a larder, and, like a mouse, commits its petty thefts upon the fattest parts of the bacon. But this happens seldom, the general tenor of its industry is employed in pursuing insects that are much more noxious to us than itself can possibly be, while its evening flight, and its unsteady wabbling motion, amuse the imagination, and add one figure more to the pleasing group of animated nature.

The varieties of this animal, especially in our country, are but few, and the differences scarcely worth enumeration. Naturalists mention the Long-eared Bat, much less than that generally seen, and with much longer ears, the Horse-shoe Bat, with an odd protuberance round its upper lip, somewhat in the form of a horse-shoe, the Rhinoceros Bat, with a horn growing from the nose, somewhat similar to that animal from whence it has the name. These, with several others, whose varieties are too numerous, and differences too minute for a detail, are all inoffensive, minute, and contemptible, incapable, from their size, of injuring mankind, and not sufficiently numerous much to incommode him. But there is a larger race of bats, found in the East and West Indies, that are truly formidable, each of these is singly a dangerous enemy, but when they unite in flocks, they then become dreadful. Were the inhabitants of the African coasts,* says Des Marchais, to eat animals

* Des Marchais, vol. ii. p. 206

of the Bat kind as they do in the East Indies, they would never want a supply of provisions. They are there in such numbers that when they fly they obscure the setting sun. In the morning at peep of day they are seen sticking upon the tops of the trees and clinging to each other like bees when they swarm or like large clusters of cocoa. The Europeans often amuse themselves with shooting among this huge mass of living creatures and observing their embarrassment when wounded. They sometimes enter the houses and the negroes are expert at killing them but although these people seem for ever hungry yet they regard the bat with horror, and will not eat it though ready to starve.

Of foreign bats the largest we have any certain accounts of is the Rousette or the Great Bat of Madagascar. This formidable creature is near four feet broad when the wings are extended and a foot long from the tip of the nose to the insertion of the tail. It resembles our bat in the form of its wings in its manner of flying and in its internal conformation. It differs from it in its enormous size in its colour which is red like that of a fox in its head and nose also which resemble those of that animal and which have induced some to call it the flying fox. It differs also in the number of its teeth and in having a claw on the fore foot which is wanting in ours. This formidable creature is found only in the ancient continent particularly in Madagascar along the coasts of Africa and Malabar where it is usually seen about the size of a large hen. When they repose they stick themselves to the tops of the tallest trees and hang with their heads downward. But when they are in motion nothing can be more formidable they are seen in clouds darkening the air as well by day as by night destroying the ripe fruits of the country and sometimes settling upon animals and man himself they devour indiscriminately fruits flesh and insects and drink the juice of the palm tree they are heard at night in the forests at more than two miles distance with a horrible din but at the approach of day they usually begin to retire nothing is safe from their depredations they destroy fowls and domestic animals unless preserved with the utmost care and often fasten upon the inhabitants themselves attack them in the face and inflict very terrible wounds. In short as some have already observed the ancients seem to have taken

their ideas of harpies from these fierce and voracious creatures, as they both concur in many parts of the description, being equally deformed, greedy, uncleanly, and cruel

An animal not so formidable, but more mischievous than these, is the American Vampyre. This is still less than the former, but more deformed, and still more numerous. It is furnished with a horn like the rhinoceros bat, and its ears are extremely long. The other kinds generally resort to the forest, and the most deserted places, but these come into towns and cities, and, after sun-set, when they begin to fly, cover the streets like a canopy*. They are the common pest both of men and animals; they effectually destroy the one, and often distress the other. "They are," says Ulloa, "the most expert blood-letters in the world. The inhabitants of those warm latitudes being obliged, by the excessive heats, to leave open the doors and windows of the chambers where they sleep, the vampyres enter, and if they find any part of the body exposed, they never fail to fasten upon it. There they continue to suck the blood, and it often happens that the person dies under the operation. They insinuate their tooth into a vein, with all the art of the most experienced surgeon, continuing to exhaust the body until they are satiated. I have been assured," continues he, "by persons of the strictest veracity, that such an accident has happened to them, and that had they not providentially awaked, their sleep would have been their passage into eternity; having lost so large a quantity of blood as hardly to find strength to bind up the orifice. The reason why the puncture is not felt, is, besides the great precaution with which it is made, the gentle refreshing agitation of the bat's wings, which contribute to increase sleep, and soften the pain."

The purport of this account has been confirmed by various other travellers, who all agree that this bat is possessed of a faculty of drawing the blood from persons sleeping, and thus often destroying them before they awake. But still a very strong difficulty remains to be accounted for; the manner in which they inflict the wound. Ulloa, as has been seen, supposes that it is done by a single tooth, but this we know to be impossible, since the animal cannot infix one tooth without all the rest accompanying its motions; the

* Ulloa, vol. i. p. 58.

teeth of the bat kind being pretty even and the mouth but small Mr Buffon therefore supposes the wound to be inflicted by the tongue which however appears to me too large to inflict an unprunful wound and even less qualified for that purpose than the teeth Nor can the tongue as Mr Buffon seems to suppose serve for the purposes of suction since for this it must be hollow like a syringe which it is not found to be I should therefore suppose that the animal is endowed with a strong power of suction, and that without inflicting any wound whatsoever by continuing to draw it enlarges the pores of the skin in such a manner that the blood at length passes and that more freely the longer the operation is continued so that at last when the bat goes off the blood continues to flow In confirmation of this opinion we are told that where beasts have a thick skin this animal cannot injure them whereas in horses mules and asses they are very liable to be thus destroyed As to the rest these animals are considered as one of the great pests of South America and often prevent the peopling of many parts of that continent having destroyed at Barja and several other places such cattle as were brought there by the missionaries in order to form a settlement

CHAP. V

OF AMPHIBIOUS QUADRUPEDS

THE gradations of nature from one class of beings to another are made by imperceptible deviations As we saw in the foregoing chapters quadrupeds almost degraded into the insect tribe or mounted among the inhabitants of the air we are at present to observe their approach to fishes to trace the degrees by which they become more unlike terrestrial animals till the similitude of the fish prevails over that of the quadruped

As in opposite armies the two bodies are distinct and separated from each other while yet between them are various troops that plunder on both sides and are friends to neither so between terrestrial and aquatic animals there are tribes that can scarcely be referred to any rank but lead an amphibious life between them Sometimes in water some

times on land, they seem fitted for each element, and yet completely adapted to neither. Wanting the agility of quadrupeds upon land, and the perseverance of fishes in the deep, the variety of their powers only seems to diminish their force, and, though possessed of two different methods of living, they are more inconveniently provided than such as have but one.

All quadrupeds of this kind, though covered with hair in the usual manner, are furnished with membranes between the toes, which assist their motion in the water. Their paws are broad, and their legs short, by which they are more completely fitted for swimming, for, taking short strokes at a time, they make them oftener and with greater rapidity. Some, however, of these animals are more adapted to live in the water than others, but, as their power increases to live in the deep, their unfitness for living upon land increases in the same proportion. Some, like the otter, resemble quadrupeds in every thing except in being in some measure web-footed, others depart still further, in being, like the beaver, not only web-footed, but having the tail covered with scales, like those of a fish. Others depart yet farther, as the seal and the morse, by having the hind feet stuck to the body like fins; and others, as the lamentein, almost entirely resemble fishes, by having no hind feet whatsoever. Such are the gradations of the amphibious tribe. They all, however, get their living in the water, either by habit or conformation, they all continue a long time under water, they all consider that element as their proper abode, whenever pressed by danger, they fly to the water for security; and, when upon land, appear watchful, timorous, and unwieldy.

THE OTTER *

In the first step of the progression from land to amphibious animals, we find the Otter, resembling those of the terrestrial kind in shape, hair, and internal conformation; resembling the aquatic tribes in its manner of living, and in having membranes between the toes to assist it in swimming. From this peculiar make of its feet, which are very

* The otter differs in no respect from the weasel kind, except in having the feet webbed, and in living almost constantly in the water, from whence they chiefly derive their food, which is fish.

short it swims even faster than it runs and can overtake fishes in their own element. The colour of this animal is brown and it is somewhat of the shape of an overgrown weasel being long slender and soft skinned. However if we examine its figure in detail we shall find it unlike any other animal hitherto described and of such a shape as words can but weakly convey. Its usual length is about two feet from the tip of the nose to the insertion of the tail the head and nose are broad and flat the mouth bears some similitude to that of a fish the neck is short and equal in thickness to the head the body long the tail broad at the insertion but tapering off to a point at the end, the eyes are very small and placed nearer the nose than usual in quadrupeds. The legs are very short but remarkably strong broad and muscular. The joints are articulated so loosely that the animal is capable of turning them quite back and bringing them on a line with the body so as to perform the office of fins. Each foot is furnished with five toes connected by strong broad webs like those of water fowl. Thus nature in every part has had attention to the life of an animal whose food is fish and whose haunts must necessarily be about water.

This voracious animal is never found but at the sides of lakes and rivers but particularly the former for it is seldom found of fishing in a running stream for the current of the water having more power upon it than the fishes it pursues if it hunts against the stream it swims too slow and it with the stream it overshoots its prey. However when in rivers it is always observed to swim against the stream and to meet the fishes it preys upon rather than to pursue them. In lakes it destroys much more than it devours and is often seen to spoil a pond in the space of a few nights. But the damage they do by destroying fish is not so great as their tearing in pieces the nets of the fishers which they infallibly do whenever they happen to be entangled. The instant they find themselves caught they go to work with their teeth and in a few minutes destroy nets of a very considerable value.

The otter has two different methods of fishing the one by catching its prey from the bottom upward the other by pursuing it into some little creek and seizing it there. In the former case as this animal has longer lungs than most

other quadrupeds, upon taking in a quantity of air, it can remain for some minutes at the bottom, and whatever fish passes over at that time is certainly taken, for as the eyes of fish are placed so as not to see under them, the otter attacks them off their guard from below; and, seizing them at once by the belly, drags them on shore, where it often leaves them untouched, to continue the pursuit for hours together. The other method is chiefly practised in lakes and ponds, where there is no current. the fish thus taken are rather of the smaller kind, for the great ones will never be driven out of deep water.

In this manner the otter usually lives during the summer, being furnished with a supply much greater than its consumption. killing for its amusement, and infecting the edges of the lake with quantities of dead fish, which it leaves there as trophies rather of its victory than its necessities. But in winter, when the lakes are frozen over, and the rivers pour with a rapid torrent, the otter is often greatly distressed for provisions, and is then obliged to live upon grass, weeds, and even the bark of trees. It then comes upon land, and, grown courageous from necessity, feeds upon terrestrial animals, rats, insects, and even sheep themselves. Nature, however, has given it the power of continuing a long time without food, and although, during that season, it is not rendered quite torpid, like the marmout or the dormouse, yet it keeps much more within its retreat, which is usually the hollow of a bank, worn under by the water. There it often forms a kind of gallery, running for several yards along the edge of the water; so that when attacked at one end, it flies to the other, and often evades the fowler by plunging into the water at forty or fifty paces distance, while he expects to find it just before him.

We learn from M^r Buffon, that this animal, in France, couples in winter, and brings forth in the beginning of spring. But it is certainly different with us, for its young are never found till the latter end of summer, and I have frequently, when a boy, discovered their retreats, and pursued them at that season. I am, therefore, more inclined to follow the account given us of this animal by M^r Lots, of the Academy of Stockholm, who assures us that it couples about the middle of summer, and brings forth at

the end of nine weeks generally three or four at a time. This as well as the generality of his other remarks on this subject agrees so exactly with what I remember concerning it that I will beg leave to take him for my guide assuring the reader that however extraordinary the account may seem I know it to be certainly true.

In the rivers and the lakes frequented by the otter the bottom is generally stony and uneven with many trunks of trees and long roots stretching underneath the water. The shore also is hollow and scooped inward by the waves. These are the places the otter chiefly chooses for its retreat and there is scarcely a stone which does not bear the mark of its residence as upon them its excrements are always made. It is chiefly by this mark that its lurking places are known as well as by the quantity of dead fish that are found lying here and there upon the banks of the water. To take the old ones alive is no easy task as they are extremely strong and there are few dogs that will dare to encounter them. They bite with great fierceness and never let go their hold when they have once fastened. The best way therefore is to shoot them at once as they never will be thoroughly tamed and if kept for the purposes of fishing are always apt to take the first opportunity of escaping. But the young ones may be more easily taken and converted to very useful purposes. The otter brings forth its young generally under the hollow banks upon a bed of rushes flags or such weeds as the place affords it in the greatest quantities. I see in the British Zoology a description of its habitation where that naturalist observes that it burrows under ground on the banks of some river or lake and always makes the entrance of its hole under water then works up to the surface of the earth and there makes a minute orifice for the admission of air and this little air hole is often found in the middle of some thicket. In some places this may be true but I have never observed any such contrivance the retreat indeed was always at the edge of the water but it was only sheltered by the impending bank and the otter itself seemed to have but a small share in its formation. But be this as it may the young ones are always found at the edge of the water and if under the protection of the dam she teaches them

instantly to plunge, like herself, into the deep, and escape among the rushes or weeds that fringe the stream. At such times, therefore, it is very difficult to take them, for, though never so young, they swim with great rapidity, and in such a manner that no part of them is seen above water, except the tip of the nose. It is only when the dam is absent that they can be taken, and, in some places, there are dogs purposely trained for discovering their retreats. Whenever the dog comes to the place, he soon, by his barking, shews that the otter is there, which, if there be an old one, instantly plunges into the water, and the young all follow. But if the old one be absent, they continue terrified, and will not venture forth but under her guidance and protection. In this manner they are secured, and taken home alive, where they are carefully fed with small fish and water. In proportion, however, as they gather strength, they have milk mixed among their food, the quantity of their fish provision is retrenched, and that of vegetables is increased, until at length they are fed wholly upon bread, which perfectly agrees with their constitution. The manner of training them up to hunt for fish requires not only assiduity, but patience; however, their activity and use, when taught, greatly repays the trouble of teaching; and, perhaps, no other animal is more beneficial to its master. The usual way is, first to learn them to fetch, as dogs are instructed, but, as they have not the same docility, so it requires more art and experience to teach them. It is usually performed by accustoming them to take a truss stuffed with wool, of the shape of a fish, and made of leather, in their mouths, and to drop it at the word of command, to run after it when thrown forward, and to bring it to their master. From this they proceed to real fish, which are thrown dead into the water, and which they are taught to fetch from thence. From the dead they proceed to the live, until at last the animal is perfectly instructed in the whole art of fishing. An otter thus taught is a very valuable animal, and will catch fish enough to sustain not only itself but a whole family. I have seen one of these go to a gentleman's pond at the word of command, dive up the fish into a corner, and seizing upon the largest of the whole, bring it off, in its mouth, to its master.

Otters are to be met with in most parts of the world,

and rather differ in size and colour from each other than in habits or conformation *. In North America and Carolina they are usually found white inclining to yellow. The Brazilian otter is much larger than ours with a roundish head almost like a cat. The tail is shorter being but five inches long and the fur is soft short and black except on the head where it is of a dark brown with a yellowish spot under the throat.

THE BEAVER

In all countries as man is civilized and improved the lower ranks are repressed and degraded †. Either reduced to servitude or treated as rebels all their societies are dissolved and all their united talents rendered ineffectual. Their feeble arts quickly disappear and nothing remains but their solitary instincts or those foreign habits which they receive from human education. For this reason there remain no traces of their ancient talents and industry except in those countries where man himself is a stranger where unvisited by his controlling power for a long succession of ages their little talents have had time to come to their limited perfection and their common designs have been capable of being united.

The beaver seems to be now the only remaining monument of brutal society. From the result of its labours which are still to be seen in the remote parts of America we learn how far instinct can be aided by imitation. We from thence perceive to what a degree animals without language or reason can concur for their mutual advantage and attain by numbers those advantages which each in a state of solitude seems unfitted to possess.

If we examine the beaver merely as an individual and unconnected with others of its kind we shall find many other quadrupeds to exceed it in cunning and almost all in the powers of annoyance and defence. The beaver when taken from its fellows and kept in a state of solitude or domestic timeness appears to be a mild gentle creature familiar enough but somewhat dull and even melancholy without any violent passions or vehement appetites moving but seldom making no efforts to attain any good except in gnawing the wall of its prison, in order to regain its

* Ray

† Buffon

freedom ; yet this, however, without anger or precipitation, but calm and indifferent to all about, without attachment or antipathies, neither seeking to offend nor desiring to please. It appears inferior to the dog in those qualities which render animals of service to man, it seems made neither to serve, to command, nor to have connections with any other set of beings, and is only adapted for living among its kind. Its talents are entirely repressed in solitude, and are only brought out by society. When alone, it has but little industry, few tricks, and without cunning sufficient to guard it against the most obvious and bungling snares laid for it by the hunter. Far from attacking any other animal, it is scarcely possessed of the arts of defence. Preferring flight to combat, like all wild animals, it only resists when driven to an extremity, and fights only when its speed can no longer avail.

But this animal is rather more remarkable for the singularity of its conformation, than any intellectual superiorities it may be supposed, in a state of solitude, to possess. The beaver is the only creature among quadrupeds that has a flat broad tail, covered with scales, which serves as a rudder to direct its motions in the water. It is the sole quadruped that has membranes between the toes on the hind feet only, and none on the fore feet, which supply the place of hands, as in the squirrel. In short, it is the only animal that in its fore parts entirely resembles a quadruped, and in its hinder parts seems to approach the nature of fishes, by having a scaly tail. In other respects, it is about two feet long, and near one foot high, it is somewhat shaped like a rat, except the tail, which, as has been observed, is flat and scaly, somewhat resembling a neat's tongue at the point. Its colour is of a light brown ; the hair of two sorts ; the one longer and coarser, the other soft, fine, short, and silky. The teeth are like those of a rat or a squirrel, but longer and stronger, and admirably adapted to cutting timber or stripping bark, to which purposes they are constantly applied. One singularity more may be mentioned in its conformation, which is, that, like birds, it has but one and the same vent for the emission of its excrements and its urine ; a strange peculiarity, but which anatomists leave us no room to doubt of.

The beavers begin to assemble about the months of June

and July to form a society that is to continue for the greatest part of the year. They arrive in numbers from every side and generally form a company of above two hundred. The place of meeting is commonly the place where they fix their abode and this is always by the side of some lake or river. If it be a lake in which the waters are always upon a level they dispense with building a dam but if it be a running stream which is subject to floods and falls they then set about building a dam or pier that crosses the river so that it forms a dead water in that part which lies above and below. This dam or pier is often fourscore or a hundred feet long and ten or twelve feet thick at the base. If we compare the greatness of the work with the powers of the architect it will appear enormous but the solidity with which it is built is still more astonishing than its size. The part of the river over which this dam is usually built is where it is most shallow and where some great tree is found growing by the side of the stream. Thus they pitch upon as proper for making the principal part in their building and although it is often thicker than a man's body they instantly set about cutting it down. For this operation they have no other instrument but their teeth which soon lay it level and that also on the side they wish it to fall which is always across the stream. They then fall about cutting off the top branches to make it lie close and even and serve as the principal beam of their fabric *

This dike or causey is sometimes ten and sometimes twelve feet thick at the foundation. It descends in a declivity or slope on that side next the water which gravitates upon the work in proportion to the height and presses it with a prodigious force towards the earth. The opposite side is erected perpendicular like our walls and that declivity which at the bottom or basis is about twelve feet broad diminishes towards the top where it is no more than two feet broad or thereabouts. The materials whereof this mole consists are wood and clay. The beavers cut with surprising ease large pieces of wood some is thick as one's arm or thigh and about four five or six feet in length or sometimes more according as the slope ascends. They drive one end of these stiles into the ground at a small distance one from the other intermingling a few

with them that are smaller and more pliant. As the water, however, would find a passage through the intervals or spaces between them, and leave the reservoir dry, they have recourse to a clay, which they know where to find, and with which they stop up all the cavities both within and without, so that the water is duly confined. They continue to raise the dike in proportion to the elevation of the water, and the plenty which they have of it. They are conscious, likewise, that the conveyance of their materials by land would not be so easily accomplished as by water, and therefore they take the advantage of its increase, and swim with their mortar on their tails, and then stakes between their teeth, to the places where there is most occasion for them. If their works are, either by the force of the water, or the feet of the huntsmen who run over them, in the least damaged, the breach is instantly made up, every nook and corner of the habitation is reviewed, and, with the utmost diligence and application, perfectly repaired. But when they find the huntsmen visit them too often, they work only in the night-time, or else abandon their works entirely, and seek out for some safer situation.

The dike, or mole, being thus completed, their next care is to erect their several apartments, which are either round or oval, and divided into three stories, one raised above the other. the first below the level of the causey, which is for the most part full of water, the other two above it. This little fabric is built in a very firm and substantial manner, on the edge of their reservoir, and always in such divisions or apartments as above mentioned; that, in case of the water's increase, they may move up a story higher, and be no ways incommoded. If they find any little island contiguous to their reservoir, they fix their mansion there, which is then more solid, and not so frequently exposed to the overflowing of the water, in which they are not able to continue for any length of time. In case they cannot pitch upon so commodious a situation, they drive piles into the earth, in order to fence and fortify their habitation against the wind as well as the water. They make two apertures, at the bottom, to the stream, one is a passage to their bagnio, which they always keep neat and clean, the other leads to that part of the building where every thing is conveyed that will either soil or damage their

upper apartments They have a third opening or door way, much higher contrived for the prevention of their being shut up and confined when the frost and snow has closed the apertures of the lower floors Sometimes they build their houses altogether upon dry land but then they sink trenches five or six feet deep in order to descend into the water when they see convenient They make use of the same materials and are equally industrious in the erection of their lodges as their dikes Their walls are perpendicular and about two feet thick As their teeth are more serviceable than saws they cut off all the wood that projects beyond the wall After this when they have mixed up some clay and dry grass together they work it into a kind of mortar with which by the help of their tails they plaster all their works both within and without

The inside is vaulted and is large enough for the reception of eight or ten beavers In case it rises in an oval figure it is for the generality above twelve feet long and eight or ten feet broad If the number of inhabitants increase to fifteen twenty or thirty the edifice is enlarged in proportion I have been credibly informed that four hundred beavers have been discovered to reside in one large mansion house divided into a vast number of apartments that had a free communication one with another

All these works more especially in the northern parts are finished in August or September at furthest at which time they begin to lay in their stores During the summer they are perfect epicures and regale themselves every day on the choicest fruits and plants the country affords Their provisions indeed in the winter season principally consist of the wood of the birch the plane and some few other trees which they steep in water from time to time in such quantities as are proportioned to the number of inhabitants They cut down branches from three to ten feet in length Those of the largest dimensions are conveyed to their magazines by a whole body of beavers but the smallest by one only each of them however takes a different way and has his proper walk assigned him in order that no one labourer should interrupt another in the prosecution of his work Their wood yards are larger or smaller in proportion to the number in the family and according to the observation of some curious naturalists the usual stock of

timber, for the accommodation of ten beavers, consists of about thirty feet in a square surface, and ten in depth. These logs are not thrown up in one continued pile, but laid one across the other, with intervals, or small spaces between them, in order to take out, with the greater facility, but just such a quantity as they shall want for their immediate consumption, and those parcels only, which lie at the bottom in the water, and have been duly steeped. This timber is cut again into small particles, and conveyed to one of their largest lodges, where the whole family meet, to consume their respective dividends, which are made impartially, in even and equal portions. Sometimes they traverse the woods, and regale their young with a more novel and elegant entertainment.

Such as are used to hunt these animals, know perfectly well that green wood is much more acceptable to them than that which is old and dry, for which reason they plant a considerable quantity of it round their lodgments; and as they come out to partake of it, they either catch them in snares, or take them by surprise. In the winter, when the frosts are very severe, they sometimes break a large hole in the ice, and when the beavers resort thither for the benefit of a little fresh air, they either kill them with their hatchets, or cover the opening with a large substantial net. After this, they undermine and subvert the whole fabric; whereupon the beavers, in hopes to make them escape in the usual way, fly with the utmost precipitation to the water, and plunging into the aperture, fall directly into the net, and are inevitably taken.

THE SEAL.

EVERY step we proceed in the description of amphibious quadrupeds, we make nearer advances to the tribe of fishes. We first observed the otter with its feet webbed, and formed for an aquatic life, we next saw the beaver with the hinder parts covered with scales, resembling those of fishes, and we now come to a class of animals in which the shape and habitude of fishes still more apparently prevail, and whose internal conformation attaches them very closely to the water. The seal, in general, resembles a quadruped in some respects, and a fish in others. The head is round, like that of a man; the nose broad, like that of the otter,

the teeth like those of a dog the eyes large and sparkling no external ears but holes that serve for that purpose the neck is well proportioned and of a moderate length but the body thickest where the neck is joined to it From thence the animal tapers down to the tail growing all the way smaller like a fish The whole body is covered with a thick bristly shining hair which looks as if it were entirely rubbed over with oil, and thus fir the quadruped prevails over the aquatic But it is in the feet that this animal greatly differs from all the rest of the quadruped kind for though furnished with the same number of bones with other quadrupeds yet they are so stuck on the body and so covered with a membrane that they more resemble fins than feet and might be taken for such did not the claws with which they are pointed shew their proper analogy In the fore feet or rather hands all the arm and the cubit are hid under the skin and nothing appears but the hand from the wrist downwards so that if we imagine a child with its arms swathed down and nothing appearing but its hands at each side of the body towards the breast we may have some idea of the formation of this animal in that part These hands are covered in a thick skin which serves like a fin for swimming and are distinguished by five claws which are long black and piercing As to the hind feet they are stretched out on each side of the short tail covered with a hairy skin like the former and both together almost joining at the tail the whole looks like the broad flat tail of a fish and were it not for five claws which appear might be considered as such The dimensions of this animal are various being found from four feet long to nine They differ also in their colours some being black others spotted some white and many more yellow It would therefore be almost endless to mention the varieties of this animal Buffon describes three and Krantz mentions five all different from those described by the other I might were I fond of such honours claim the merit of being a first describer myself but in fact the varieties of this animal are so many that were they all described the catalogue would be as extensive as it would be useless and unenterprising It is sufficient to observe that they agree in the general external characters already mentioned and internally in two or

three more, which are so remarkable as to deserve peculiar attention.

It has been often remarked, that all animals are sagacious in proportion to the size of their brain. It has, in support of this opinion, been alleged, that man, with respect to his bulk, has, of all others, the largest. In pursuance of this assumption, some erroneous speculations have been formed. But, were the size of the brain to determine the quantity of the understanding, the seal would, of all other animals, be the most sagacious, for it has, in proportion, the largest brain of any, even man himself not excepted. However, this animal is possessed of but very few advantages over other quadrupeds, and the size of its brain furnishes it with few powers that contribute to its wisdom or its preservation.

This animal differs also in the formation of its tongue from all other quadrupeds. It is forked or slit at the end, like that of serpents, but for what purpose it is thus singularly contrived we are at a loss to know. We are much better informed with respect to a third singularity in its conformation, which is, that the *foramen ovale* in the heart is open. Those who are in the least acquainted with anatomy, know, that the veins uniting bring their blood to the heart, which sends it into the lungs, and from thence it returns to the heart again to be distributed through the whole body. Animals, however, before they are born, make no use of their lungs; and therefore their blood, without entering their lungs, takes a shorter passage through the very partition of the heart, from one of its chambers to the other, thus passing from the veins directly into those vessels that drive it through the whole frame. But the moment the animal is brought forth, the passage through the partition, which passage is called the *foramen ovale*, closes up, and continues closed for ever, for the blood then takes its longest course through the lungs to return to the other chamber of the heart again. Now the seal's heart resembles that of an infant in the womb, for the *foramen ovale* never closes,* and although the blood of

* I have followed the usual observations of naturalists with respect to the *foramen ovale* in this animal. I have many reasons, however, to incline me to think that the *foramen* is not entirely open. But this is not the place for a critical inquiry of this kind.

this animal commonly circulates through the lungs yet it can circulate without their assistance as was observed above by a shorter way. From hence therefore we see the manner in which this animal is adapted for continuing under water for being under no immediate necessity of breathing the vital motions are still carried on while it continues at the bottom so that it can pursue its prey in that element and yet enjoy all the delights and advantages of ours.

The water is the seal's usual habitation and whatever fish it can catch its food. Though not equal in instinct and cunning to some terrestrial animals it is greatly superior to the mute tenants of that element in which it chiefly resides. Although it can continue for several minutes under water yet it is not able like fishes to remain there for any length of time, and a seal may be drowned like any other terrestrial animal. Thus it seems superior in some respects to the inhabitants of both elements and inferior in many more. Although furnished with legs it is in some measure deprived of all the advantages of them*. They are shut up within its body while nothing appears but the extremities of them and these furnished with very little motion but to serve them as fins in the water. The land feet indeed being turned backwards are entirely useless upon land so that when the animal is obliged to move it drags itself forward like a reptile and with an effort more painful. For this purpose it is obliged to use its fore feet which though very short serve to give it such a degree of swiftness that a man cannot readily overtake it and it runs towards the sea. As it is thus awkwardly formed for going upon land it is seldom found at any distance from the sea shore but continues to bask upon the rocks and when disturbed always plunges down at once to the bottom.

The seal is a social animal and wherever it frequents numbers are generally seen together. They are found in every climate but in the north and icy seas they are particularly numerous. It is on those shores which are less inhabited than ours and where the fish resort in greater abundance that they are seen by thousands like flocks of sheep basking on the rocks and suckling their young. There they keep watch like other gregarious animals and

if an enemy appear, instantly plunge all together into the water. In fine weather they more usually employ their time in fishing; and generally come on shore in tempests and storms. The seal seems the only animal that takes delight in these tremendous conflicts of nature. In the midst of thunders and torrents, when every other creature takes refuge from the fury of the elements, the seals are seen by thousands sporting along the shore, and delighted with the universal disorder! This, however, may arise from the sea being at that time too turbulent for them to reside in; and they may then particularly come upon land when unable to resist the shock of their more usual element.

As seals are gregarious, so are they also animals of passage, and perhaps the only quadrupeds that migrate from one part of the world to another. The generality of quadrupeds are contented with their native plains and forests, and seldom stray, except when necessity or fear impels them. But seals change their habitation, and are seen in vast multitudes directing their course from one continent to another*. On the northern coasts of Greenland they are seen to retire in July, and to return again in September. This time it is supposed they go in pursuit of food. But they make a second departure in March, to cast their young, and return in the beginning of June, young and all, in a great body together, observing in their route a certain fixed time and track, like birds of passage. When they go upon this expedition, they are seen in great droves, for many days together, making towards the north, taking that part of the sea most free from ice, and going still forward into those seas where man cannot follow. In what manner they return, or by what passage, is utterly unknown, it is only observed, that when they leave the coasts to go upon this expedition, they are all extremely fat, but on their return they come home excessively lean.

The females, in our climate, bring forth in winter, and rear their young upon some sand-bank, rock, or desolate island, at some distance from the continent. When they suckle their young they sit up on their hinder-legs, while these, which are at first white, with woolly hair, cling to the teats, of which there are four in number, near the navel.† In this manner the young continue in the place

* Krantz, vol 1 p 129

† Coeunt in littore resupinata femina. LIN SYST

where they are brought forth for twelve or fifteen days after which the dam brings them down to the water and accustoms them to swim and get their food by their own industry. As each litter never exceeds above three or four so the animal's cares are not much divided and the education of her little ones is soon completed. In fact the young are particularly docile they understand the mother's voice among the numerous bleatings of the rest of the old ones they mutually assist each other in danger and are perfectly obedient to her call. Thus early accustomed to subjection they continue to live in society, hunt and herd together and have a variety of tones by which they encourage to pursue or warn each other of danger. Some compare their voices to the bleating of a flock of sheep interrupted now and then by the barking of angry dogs and sometimes the shriller notes of a cat. All along the shore each has its own peculiar rock of which it takes possession and where it sleeps when fatigued with fishing uninterrupted by any of the rest. The only season when their social spirit seems to forsake them is that when they feel the influences of natural desire. They then fight most desperately and the male that is victorious keeps all the females to himself. Their combats on these occasions are managed with great obstinacy and yet great justice two are never seen to fall upon one together but each has its antagonist, and all fight an equal battle, till one alone becomes victorious.

We are not certainly informed how long the females continue pregnant but if we may judge from the time which intervenes between their departure from the Greenland coasts and their return they cannot go above seven or eight months at the farthest. How long this animal lives is also unknown a gentleman whom I knew in Ireland kept two of them which he had taken very young in his house for ten years and they appeared to have the marks of age at the time I saw them for they were grown gray about the muzzle and it is very probable they did not live many years longer. In their natural state the old ones are seen very fat and torpid separated from the rest, and as it should seem incapable of procreation.

As their chief food is fish so they are very expert at pursuing and catching it. In those places where the herds are seen in shoals the seals frequent and destroy them

by thousands. When the herring retires, the seal is then obliged to hunt after fish that are stronger and more capable of evading the pursuit. however, they are very swift in deep waters, dive with great rapidity, and, while the spectator eyes the spot at which they disappear, they are seen to emerge at above a hundred yards distance. The weaker fishes, therefore, have no other means to escape their tyranny, but by darting into the shallows. The seal has been seen to pursue a mullet, which is a swift swimmer, and to turn it to and fro in deep water, as a hound does a hare on land. The mullet has been seen trying every art of evasion; and at last swimming into shallow water, in hopes of escaping. There, however, the seal followed; so that the little animal had no other way left to escape, but to throw itself on one side, by which means it darted into shoaler water than it could have swam in with the belly undermost, and thus at last it got free.

As they are thus the tyrants of the element in which they chiefly reside, so they are not very fearful even upon land, except on those shores which are thickly inhabited, and from whence they have been frequently pursued. Along the desert coasts, where they are seldom interrupted by man, they seem to be very bold and courageous, if attacked with stones, like dogs, they bite such as are thrown against them; if encountered more closely, they make a desperate resistance, and, while they have any life, attempt to annoy their enemy. Some have been known, even while they were skinning, to turn round and seize their butchers; but they are generally dispatched by a stunning blow on the nose. They usually sleep soundly when not frequently disturbed, and that is the time when the hunters surprise them. The Europeans who go into the Greenland seas upon the whale fishery, surround them with nets, and knock them on the head, but the Greenlanders, who are unprovided with so expensive an apparatus, destroy them in a different manner. One of these little men paddles away in his boat, and when he sees a seal asleep on the side of a rock, darts his lance, and that with such unerring aim, that it never fails to bury its point in the animal's side. The seal, feeling itself wounded, instantly plunges from the top of the rock, lance and all, into the sea, and dives to the bottom; but the lance has a bladder tied to one end, which keeps buoyant, and resists the animal's descent; so that every time the seal rises to the top of the water the

Greenlander strikes it with his or until he at last dispatches it. But in our climate the seals are much more wary and seldom suffer the hunters to come near them. They are often seen upon the rocks of the Cornish coast basking in the sun or upon the inaccessible cliffs left dry by the tide. There they continue extremely watchful and never sleep long without moving seldom longer than a minute for then they raise their heads and if they see no danger they lie down again rising and reclining their heads alternately at intervals of about a minute each. The only method therefore that can be taken is to shoot them if they chance to escape they hasten towards the deep flinging stones and dirt behind them as they scramble along and at the same time expressing their pain or their fears by the most distressful cry if they happen to be overtaken they make a vigorous resistance with their feet and teeth till they are killed.

The seal is taken for the sake of its skin and for the oil its fat yields. The former sells for about four shillings and when dressed is very useful in covering trunks making waistcoats shot pouches and several other conveniences. The flesh of this animal formerly found place at the tables of the great. At a feast provided by Archbishop Neville for Edward the Fourth there were twelve seals and porpoises provided among other extraordinary rarities.

As a variety of this animal we may mention the SEA LION described in Anson's Voyages. This is much larger than any of the former being from eleven to eighteen feet long. It is so fat that when the skin is taken off the blubber lies a foot thick all round the body. It seems to differ from the ordinary seal not only in its size but also in its food for it is often seen to graze along the shore and to feed upon the long grass that grows up along the edges of brooks. Its cry is very various sometimes resembling the neighing of a horse and sometimes the grunting of a hog. It may be regarded as the largest of the seal family.

THE MORSE

THE MORSE is an animal of the seal kind but differing from the rest in a very particular formation of the teeth having two large tusks growing from the upper jaw shaped like those of an elephant but directed downwards whereas

in the elephant, they grow upright, like horns, it also wants the cutting teeth, both above and below. as to the rest, it pretty much resembles a seal, except that it is much larger, being from twelve to sixteen feet long. The moises are also generally seen to frequent the same places that seals are known to reside in, they have the same habitudes, the same advantages, and the same imperfections. There are, however, fewer varieties of the morse than the seal, and they are rarely found, except in the frozen regions near the pole. They were formerly more numerous than at present, and the savage natives of the coasts of Greenland destroyed them in much greater quantities, before those seas were visited by European ships upon the whale-fishery, than now. Whether these animals have been since actually thinned by the fishers, or have removed to some more distant and unfrequented shores, is not known; but certain it is, that the Greenlanders, who once had plenty, are now obliged to toil more assiduously for subsistence; and as the quantity of their provisions decrease, for they live mostly upon seals, the numbers of that poor people are every day diminishing. As to the teeth, they are generally from two to three feet long, and the ivory is much more esteemed than that of the elephant, being whiter and harder. The fishers have been known formerly to kill three or four hundred at once, and along those shores where they chiefly frequented, their bones are still seen lying in prodigious quantities. In this manner a supply of provisions, which would have supported the Greenland nation for ages, has been, in a few years, sacrificed to those who did not use them, but who sought them for the purposes of avarice and luxury.

THE MANATI.

WE come, in the last place, to an animal that terminates the boundary between quadrupeds and fishes. Instead of a creature preying among the deeps, and retiring upon land for repose or refreshment, we have here an animal that never leaves the water, and is enabled to live only there. It cannot be called a quadruped, as it has but two legs only; nor can it be called a fish, as it is covered with hair. In short, it forms the link that unites those two great tribes to each other, and may be indiscriminately called the last of beasts, or the first of fishes.

We have seen the seal approaching nearly to the aquatic tribes by having its hind legs thrown back on each side of the tail and forming something that resembled the tail of a fish, but upon examining the skeleton of that animal its title to the rank of a quadruped was observed plainly to appear having all the bones of the hinder legs and feet as complete as any other animal whatsoever

But we are now come to a creature that not only wants the external appearance of hinder legs but when examined internally will be found to want them altogether. The Manati is somewhat shiped in the head and the body like a seal, it has also the fore legs or hands pretty much in the same manner short and webbed but with four claws only these also are shorter in proportion than in the former animal and placed nearer the head so that they can scarcely assist its motions upon land. But it is in the hinder parts that it chiefly differs from all others of the seal kind for the tail is perfectly that of a fish being spread out broad like a fan and wanting even the vestiges of those bones which make the legs and feet in others of its kind. The largest of these are about twenty six feet in length the skin is blackish very tough and hard when cut as black as ebony and there are a few hairs scattered like bristles of about an inch long. The eyes are very small in proportion to the animal's head and the ear holes for it has no external ears are so narrow as scarcely to admit a pin's head. The tongue is so short that some have pretended it has none at all and the teeth are composed only of two solid white bones running the whole length of both jaws and formed merely for chewing and not tearing its vegetable food. The female has breasts placed forward like those of a woman and she brings forth but one at a time this she holds with her paws to her bosom there it sticks and accompanies her wherever she goes

This animal can scarcely be called amphibious as it never entirely leaves the water only advancing the head out of the stream to reach the grass on the river sides. Its food is entirely upon vegetables and therefore it is never found far in the open sea but chiefly in the large rivers of South America and often above two thousand miles from the ocean. It is also found in the seas near Kamtschatka and feeds upon the weeds that grow near the shore. There are

likewise level greens at the bottom of some of the Indian bays, and there the manaties are harmlessly seen grazing among turtles and other crustaceous fishes, neither giving nor fearing any disturbance. These animals, when unmolested, keep together in large companies, and surround their young ones *. They bring forth most commonly in autumn; and it is supposed they go with young eighteen months, for the time of generation is in spring.

The manati has no voice nor cry, for the only noise it makes is by fetching its breath. Its internal parts somewhat resemble those of a horse; its intestines being longer, in proportion, than those of any other creature, the horse only excepted.

The fat of the manati, which lies under the skin, when exposed to the sun, has a fine smell and taste, and far exceeds the fat of any sea animal; it has this peculiar property, that the heat of the sun will not spoil it, nor make it grow rancid, its taste is like the oil of sweet almonds; and it will serve very well, in all cases, instead of butter: any quantity may be taken inwardly with safety, for it has no other effect than keeping the body open. The fat of the tail is of a harder consistence; and, when boiled, is more delicate than the former. The lean is like beef, but more red, and may be kept a long while, in the hottest days, without tainting. It takes up a long time in boiling; and, when done, eats like beef. The fat of the young ones is like pork, the lean is like veal, and, upon the whole, it is very probable that this animal's flesh somewhat resembles that of turtle; since they are fed in the same element, and upon the very same food. The turtle is a delicacy well known among us. our luxuries are not as yet sufficiently heightened to introduce the manati, which, if it could be brought over, might singly suffice for a whole corporation !

~ Acta Petropolitana

[To these amphibious quadrupeds may be added that most extraordinary animal, the DUCK-BILLED PLATYPUS, described by Dr Shaw in his Naturalist's Miscellany. The body is depressed, and has some resemblance to that of an otter in miniature, and is covered with a soft beaver-like fur, but its most striking peculiarity is the strange situation of its mouth or snout, exhibiting the perfect resemblance of the beak of a duck engrafted on the head of a quadruped, and so accurate is the similitude, that at first view it naturally excites the idea of some deceptive preparation by artificial means. It is a native of New Holland.]

BOOK VII

OF THE MONKEY KIND — THE FLIGHTY RHINOCEROS ETC.

CHAP I

ANIMALS OF THE MONKEY KIND

QUADRUPEDS may be considered as a numerous group terminated on every side by some that but in part deserve the name. On one quarter we see a tribe covered with quills or furnished with wings that lift them among the inhabitants of the air on another we behold a diversity clothed with scales and shells to rank with insects and still on a third we see them descending into the waters to live among the tenants of that element. We now come to a numerous tribe that leaving the brute creation seem to make approaches even to humanity that bear an awkward resemblance of the human form and discover some faint efforts at intellectual sagacity.

Animals of the monkey class are furnished with hands instead of paws their ears eyes eye lids lips and breasts are like those of mankind, their internal conformation also bears some distant likeness and the whole offers a picture that may well mortify the pride of such as make their persons alone the principal object of their admiration. These approaches however are gradual and some bear the marks of this our boasted form more strongly than others.

In the Ape* kind we see the whole external machine strongly impressed with the human likeness and capable of the same exertions these walk upright want a tail have fleshy posteriors have claws to their legs and feet nearly like ours.

* Caubasson relates a laughable story of an ape which became so attached to him as to be desirous of accompanying him wherever he went. Once the animal secretly followed the father to church where silently mounting on the top of the sounding board above the pulpit he lay perfectly still till the sermon began. He then crept to the edge

loud and continued roar of laughter. A friend of the preacher at length pointing out to him the cause of this improper conduct it was with the utmost difficulty he could command a serious countenance while he ordered the servants of the church to take the ape away.

In the Baboon kind we perceive a more distant approach to the human form, the quadruped mixing in every part of the animal's figure. these generally go upon all-fours, but some, when upright, are as tall as a man; they have short tails, long snouts, and are possessed of brutal fierceness.

The Monkey kind are removed a step further, these are much less than the former, with tails as long, or longer, than their bodies, and flattish faces.

Lastly, the Maki and Oppossum kind, seem to lose all resemblance of the human figure, except in having hands; their noses are lengthened out, like those of quadrupeds, and every part of their bodies totally different from the human; however, as they grasp their food, or other objects, with one hand, which quadrupeds cannot do, this single similitude gives them an air of sagacity, to which they have scarcely any other pretensions.

From this slight survey it may be easily seen that one general description will not serve for animals so very different from each other. nevertheless, it will be fatiguing to the last degree, as their varieties are so numerous, and their differences so small, to go through a particular description of each. In this case it will be best to give a history of the foremost in each class, at the same time marking the distinctions in every species. By this we shall avoid a tedious repetition of similar characters, and consider the manners and the oddities of this fantastic tribe in general points of view, where we shall perceive how nearly they approach to the human figure, and how little they benefit by the approximation. The foremost of the Ape kind is

THE OURAN-OUTANG,

OR WILD MAN OF THE WOODS

THIS name seems to have been given to various animals, agreeing in one common character of walking upright, but coming from different countries, and of very different proportions and powers. The TROGLODYTE of Bontius, the DRILL of Purchas, and the PIGMY of Tyson, have all received this general name, and have been ranked, by some naturalists, under one general description. If we read the accounts of many remote travellers, under this name we are presented with a formidable animal, from six to eight feet

high, if we examine the books of such as have described it nearer home we find it a pigmy not above three. In this diversity we must be content to blend their various descriptions into one general account observing at the same time that we have no reason to doubt any of their relations although we are puzzled which to follow.

The Ourin Outang which of all other animals most nearly approaches to the human race is seen of different sizes from three to seven feet high. In general however its stature is less than that of a man but its strength and agility much greater. Travellers who have seen various kinds of these animals in their native solitudes give us surprising relations of their force their swiftness their address and their ferocity. Naturalists who have observed their form and manners at home have been as much struck with their patient pliant imitative dispositions, with their appearance and conformation so nearly human. Of the smallest sort of these animals we have had several at different times brought into this country all nearly alike but that observed by Dr. Tyson is the best known having been described with the greatest exactness.

The animal which was described by that learned physician was brought from Angola in Africa where it had been taken in the internal parts of the country in company with a female of the same kind that died by the way. The body was covered with hair which was of a coal black colour more resembling human hair than that of brutes. It bore a still stronger similitude in its different lengths, for in those places where it is longest on the human species it was also longest in this as on the head the upper lip the chin and the pubes. The face was like that of a man the forehead larger and the head round. The upper and lower jaw were not so prominent as in monkeys but flat like those of a man. The ears were like those of a man in most respects and the teeth had more resemblance to the human than those of any other creature. The bending of the arms and legs were just the same as in a man and in short the animal at first view presented a figure entirely human.

In order to discover its differences it was necessary to take a closer survey and then the imperfections of its form began to appear. The first obvious difference was in the flatness of the nose the next in the lowness of the fore

head, and the wanting the prominence of the chin. The ears were proportionably too large; the eyes too close to each other; and the interval between the nose and mouth too great. The body and limbs differed, in the thighs being too short, and the arms too long, in the thumb being too little, and the palm of the hand too narrow. The feet also were rather more like hands than feet; and the animal, if we may judge from the figure, bent too much upon its haunches.

When this creature was examined anatomically, a surprising similitude was seen to prevail in its internal conformation. It differed from man in the number of its ribs, having thirteen; whereas, in man, there are but twelve. The vertebræ of the neck also were shorter, the bones of the pelvis narrower, the orbits of the eyes were deeper, the kidneys were rounder, the urinary and gall-bladders were longer and smaller, and the ureters of a different figure. Such were the principal distinctions between the internal parts of this animal and those of man; in almost every thing else they were entirely and exactly the same, and discovered an astonishing congruity. Indeed, many parts were so much alike in conformation that it might have excited wonder how they were productive of such few advantages. The tongue, and all the organs of the voice, were the same, and yet the animal was dumb, the brain was formed in the same manner with that of man, and yet the creature wanted reason. an evident proof (as Mr Buffon finely observes) that no dispositions of matter will give mind; and that the body, how nicely soever formed, is formed in vain, when there is not infused a soul to direct its operations.

Having thus taken a comparative view of this creature with man, what follows may be necessary to complete the general description. This animal was very hairy all behind, from the head downwards, and the hair so thick that it covered the skin almost from being seen. but in all parts before, the hair was much thinner, the skin every where appeared, and in some places it was almost bare. When it went on all-fours, as it was sometimes seen to do, it appeared all hairy, when it went erect it appeared before less hairy, and more like a man. Its hair, which in this particular animal was black, much more resembled

that of men than the fur of brutes for in the latter besides their long hair there is usually a finer and a shorter intermixed, but in the ouran outang it was all of a kind only about the pubes the hair was grayish seemed longer and somewhat different as also on the upper lip and chin where it was grayish like the hair of a beard The face hands and soles of the feet were without hair and so was most part of the forehead but down the sides of the face the hair was thick it being there about an inch and a half long which exceeded that on any other part of the body In the palms of its hands were remarkable those lines which are usually taken notice of in palmistry and at the tips of the fingers those spiral lines observed in man The palms of the hands were as long as the soles of the feet and the toes upon these were as long as the fingers the middle toe was the longest of all and the whole foot differed from the human The hinder feet being thus formed as hands the animal often used them as such and on the contrary, now and then made use of its hands instead of feet The breasts appeared small and shrivelled but exactly like those of a man the navel also appeared very far and in exact dispositions being neither harder nor more prominent than what is usually seen in children Such is the description of this extraordinary creature to which little has been added by succeeding observers except that the colour of the hair is often found to vary in that described by Edwards it was of a reddish brown

From a picture so like that of the human species we are naturally led to expect a corresponding mind and it is certain that such of these animals as have been shown in Europe have discovered a degree of imitation beyond what any quadruped can arrive at

That of Lyson was a gentle fond harmless creature In its passage to England those that it knew on ship board it would embrace with the greatest tenderness opening their bosoms and clasping its hands about them Monkeys of a lower species it held in utter aversion it would always avoid the place where they were kept in the same vessel and seemed to consider itself as a creature of higher extraction After it was taken and a little used to wear clothes it grew very fond of them, and part it would put on without any help

and the rest it would carry in its hands to some of the company, for their assistance. It would lie in a bed, place its head on the pillow, and pull the clothes upwards as a man would do

That which was seen by Edwards, and described by Buffon, shewed even a superior degree of sagacity. It walked, like all of its kind, upon two legs, even though it carried burdens. Its air was melancholy, and its deportment grave. Unlike the baboon or monkey, whose motions are violent, and appetites capricious, who are fond of mischief, and obedient only from fear, this animal was slow in its motions, and a look was sufficient to keep it in awe. I have seen it, says M^r. Buffon, give its hand to shew the company to the door. I have seen it sit at table, unfold its napkin, wipe its lips, make use of the spoon and the fork to carry the victuals to its mouth, pour out its drink into a glass, touch glasses when invited, take a cup and saucer and lay them on the table, put in sugar, pour out its tea, leave it to cool before drinking, and all this without any other instigation than the signs or the command of its master, and often of its own accord. It was gentle and inoffensive; it even approached strangers with respect, and came rather to receive caresses than to offer injuries. It was particularly fond of sugared comfits, which every body was ready to give it, and, as it had a defluxion upon the breast, so much sugar contributed to increase the disorder, and shorten its life. It continued at Paris but one summer, and died in London. It ate indiscriminately of all things, but it preferred dry and ripe fruits to all other aliments. It would drink wine, but in small quantities, and gladly left it for milk, tea, or any other sweet liquor.

Such these animals appeared when brought into Europe. However, many of their extraordinary habits were probably the result of education, and we are not told how long the instructions they received for this purpose were continued. But we learn from another account that they take but a very short time to come to a great degree of imitative perfection. M^r. L. Brosse bought two young ones, that were but a year old, from a negro; and these at that early age discovered an astonishing power of imitation *. They even then sat at the

* As quoted by Buffon, vol. xxviii p. 77.

table like men ate of every thing without distinction made use of their knife spoon and fork both to eat their meat and help themselves They drank wine and other liquors When carried on ship board they had signs for the cabin boys expressive of their wants and whenever these neglected attending upon them as they desired they instantly flew into a passion seized them by the arm bit them and kept them down The male was sea sick and required attendance like a human creature he was twice bled in the arm and every time afterwards when he found himself out of order, he shewed his arm as desirous of being relieved by bleeding

Pyrard relates that in the province of Sierra Leona in Africa there are a kind of apes called Bana which are strong and muscular and which if properly instructed when young serve as very useful domestics They usually walk upright, they pound at a mortar they go to the river to fetch water thus they carry back in a little pitcher on their heads but if care be not taken to receive the pitcher at their return they let it fall to the ground and then seeing it broken they begin to lament and cry for their loss Le Comptes account is much to the same purpose of an ape which he saw in the Straits of Molucca ' It walked upon its two hind feet which is bent a little like a dog that had been taught to dance It made use of its hands and arms as we do Its visage was not much more disagreeable than that of a Hottentot but the body was all over covered with a woolly hair of different colours As to the rest it cried like a child all its outward actions were so like the human and the passions so lively and significant that dumb men could scarcely better express their conceptions and desires It had also that expression of passion or joy which we often see in children stamping with its feet and striking them against the ground to shew its spite or when refused any thing it passionately longed for Although these animals (continues he) are very big for that I saw was four feet high their numbness is incredible It is a pleasure beyond expression to see them run up the tackling of a ship where they sometimes play as if they had a knack of vaulting peculiar to themselves or as if they had been paid like our rope dancers to divert the company Sometimes suspended by one arm they poise themselves and then turn all

of a sudden round about a rope, with as much quickness as a wheel, or a sling put into motion. Sometimes holding the rope successively with their long fingers, and, letting their whole body fall into the air, they run full speed from one end to the other, and come back again with the same swiftness. There is no posture but they imitate, nor motion but they perform, bending themselves like a bow, rolling like a bowl, hanging by the hands, feet, and teeth, according to the different fancies with which their capricious imagination supplies them. But what is still more amazing than all, is their agility to fling themselves from one rope to another, though at thirty, forty, and fifty feet distance."

Such are the habitudes and the powers of the smaller class of these extraordinary creatures, but we are presented with a very different picture in those of a larger stature and more muscular form. The little animals we have been describing, which are seldom found above four feet high, seem to partake of the nature of dwarfs among the human species, being gentle, assiduous, and playful, rather fitted to amuse than terrify. But the gigantic races of the ouran outang, seen and described by travellers, are truly formidable; and in the gloomy forests, where they are only found, seem to hold undisputed dominion. Many of these are as tall or taller than a man, active, strong, and intrepid, cunning, lascivious, and cruel. This redoubtable rival of mankind is found in many parts of Africa, in the East Indies, in Madagascar, and in Borneo*. In the last of these places the people of quality course him as we do the stag; and this sort of hunting is one of the favourite amusements of the king himself. This creature is extremely swift of foot, endowed with extraordinary strength, and runs with prodigious celerity. His skin is all hairy, his eyes sunk in his head, his countenance stern, his face tanned, and all his lineaments, though exactly human, harsh and blackened by the sun. In Africa this creature is even still more formidable. Battel calls him the *pongo*, and assures us that in all his proportions he resembles a man, except that he is much larger, even to a gigantic state. His face resembles that of a man, the eyes deep sunk in the head, the hair on each side extremely long, the visage naked and without

* Le Compté's History of China

hair as also the ears and the hands. The body is lightly covered and scarcely differing from that of a man except that there are no callosities to the legs. Still however the animal is seen to walk upon his hinder legs and in an erect posture. He sleeps under trees and builds himself a hut which serves to protect him against the sun and the rains of the tropical climate of which he is a native. He lives only upon fruits and is no way carnivorous. He cannot speak although furnished with a greater instinct than any other animal of the brute creation. When the negroes make a fire in the woods this animal comes near and warms himself by the blaze. However, he has not skill enough to keep the flame alive by feeding it with fuel. They go together in companies and if they happen to meet one of the human species remote from succour, they shew him no mercy. They even attack the elephant which they beat with their clubs and oblige to leave that part of the forest which they claim as their own. It is impossible to take any of these dreadful creatures alive for they are so strong that ten men would not be a match for but one of them. None of this kind therefore are taken except when very young and these but rarely when the female happens to leave them behind for in general they keep clung to the breast and adhere both with legs and arms. From the same traveller we learn that when one of these animals dies the rest cover the body with a quantity of leaves and branches. They sometimes also shew mercy to the human kind. A negro boy that was taken by one of these and carried into the woods continued there a whole year without receiving any injury.* From another traveller we learn that these animals often attempt to surprise the female negroes as they go into the woods and frequently keep them against their wills for the pleasure of their company feeding them very plentifully all the time. He assures us that he knew a woman of Loango that had lived among these animals for three years. They grow from six to seven feet high and are of unequalled strength. They build sheds and make use of clubs for their defence. Their faces are broad their noses flat their ears without a tip their skins are more bright

* Le Brosse as quoted by Buffon vol xxviii p 70

than that of a mulatto, and they are covered on many parts of the body with long and tawny-coloured hair. Their belly is large, their heels flat, and yet rising behind. They sometimes walk upright, and sometimes upon all-fours, when they are fantastically disposed.

From this description of the ouran outang, we perceive at what a distance the first animal of the brute creation is placed from the very lowest of the human species. Even in countries peopled with savages, this creature is considered as a beast, and in those very places where we might suppose the smallest difference between them and mankind, the inhabitants hold it in the greatest contempt and detestation. In Borneo, where this animal has been said to come to its greatest perfection, the natives hunt it in the same manner as they pursue the elephant or the lion, while its resemblance to the human form procures it neither pity nor protection. The gradations of Nature in the other parts of nature are minute and insensible; in the passage from quadrupeds to fishes we can scarcely tell where the quadruped ends and the fish begins; in the descent from beasts to insects we can hardly distinguish the steps of the progression; but in the ascent from brutes to man, the line is strongly drawn, well marked, and unpassable. It is in vain that the ouran outang resembles man in form, or imitates many of his actions; he still continues a wretched helpless creature, pent up in the most gloomy part of the forest, and, with regard to the provision for his own happiness, inferior even to the elephant or the beaver in sagacity. To us, indeed, this animal seems much wiser than it really is. As we have long been used to measure the sagacity of all actions by their similitude to our own, and not their fitness to the animal's way of living, we are pleased with the imitations of the ape, even though we know they are far from contributing to the convenience of its situation. An ape, or a quadruped, when under the trammels of human education, may be an admirable object for human curiosity, but is very little advanced by all its learning in the road to its own felicity. On the contrary, I have never seen any of these long-instructed animals that did not, by their melancholy air, appear sensible of the wretchedness of their situation. Its marks of seeming sagacity were merely

relative to us and not to the animal and all its boasted wisdom was merely of our own making

There is in fact another circumstance relative to this animal which ought not to be concealed I have many reasons to believe that the most perfect of the kind are prone like the rest of the quadruped creation and only owe their erect attitude to human education Almost all the travellers who speak of them mention their going sometimes upon all fours and sometimes erect As their chief residence is among trees they are without doubt usually seen erect while they are climbing but it is more than probable that their efforts to escape upon the ground are by running upon the hands and feet together Schouten who mentions their education tells us that they are taken in traps and taught in the beginning to walk upon their hind legs which certainly implies that in a state of nature they run upon all fours Add to this that when we examine the palms of their hands and the soles of their feet we find both equally callous and beaten a certain proof that both have been equally used In those hot countries where the apes are known to reside the soles of the negroes feet who go bare foot, are covered with a skin above an inch thick while their hands are as soft as those of an European Did the apes walk in the same manner the same exercise would have furnished them with similar advantages which is not the case Besides all this I have been assured by a very credible traveller that these animals naturally run in the woods upon all fours and when they are taken their hands are tied behind them to teach them to walk upright Thus attitude they learn after some time and thus instructed they are sent into Europe to astonish the speculative with their near approaches to humanity while it is never considered how much is natural and how much has been acquired in the savage schools of Benin and Angola

The animal next to these and to be placed in the same class is the APE properly so called or the *PITHECOS* of the ancients This is much less than the former being not above a foot and a half high but walks erect is without a tail and is easily tamed

Of this kind also is the GIBBON so called by Buffon or the LONG ARMED APE which is a very extraordinary and remarkable creature It is of different sizes being from four

feet to two feet high It walks erect, is without a tail, has a face resembling that of a man, with a circle of bushy hair all round the visage; its eyes are large, and sunk in its head; its face tanned, and its ears exactly proportioned. But that in which it chiefly differs from all others of the monkey tribe, is the extraordinary length of its arms, which when the animal stands erect are long enough to reach the ground; so that it can walk upon all-fours, and yet keep its erect posture at the same time This animal, next to the ouian outang and the ape, most nearly resembles mankind, not only in form, but in gentle manners and tractable disposition It is a native of the East Indies, and particularly found along the coasts of Coromandel

The last of the ape kind is the *CYNOCEPHALUS*, or the *MAGOT* of Buffon This animal wants a tail, like the former, although there is a small protuberance at that part, which yet is rather formed by the skin than the bone It differs also in having a large callous red rump The face is prominent, and approaches more to that of quadrupeds than of man The body is covered with a brownish hair, and yellow on the belly. It is about three feet and a half, or four feet high, and is a native of most parts of Africa and the East As it recedes from man in its form, so also it appears different in its dispositions, being sullen, vicious, and untractable *

THE BABOON.

DESCENDING from the more perfect of the monkey kinds, we come to the baboon and its varieties, a large, fierce, and formidable race, that, mixing the figure of the man and the quadruped in their conformation, seem to possess only the defects of both, the petulance of the one, and the ferocity of the other These animals have a short tail; a prominent face, with canine teeth, larger than those of men; and callosities on the rump † In man the physiognomy may deceive, and the figure of the body does not always lead to the qualities of the mind, but in animals

* Omnes femellæ hujusce et precedentium, ut et fere sequentium specierum, menstruali patiuntur fluxu sicut in feminis

† Buffon, vol. XXXIII p 183

we may always judge of their dispositions by their looks, and form a just conjecture of their internal habits from their external form. If we compare the nature of the ape and the baboon by this easy rule we shall at once be led to pronounce that they greatly differ in their dispositions and that the latter are infinitely more fierce, savage and malicious than the former. The ouran outang that so nearly resembles man in its figure approaches also nearest in the gentleness of its manners and the phrensy of its temper. The cynocephalus that of all other apes is most unlike man in form and approaches nearer the dog in face, resembles the brute in nature being wild, restless and impelled by a fretful impetuosity. But the baboon who is still more remote and resembles man only in having hands who from having a tail, a prominent face and sharp claws approaches more nearly to the savage tribe is every way fierce, malicious, ignorant and untractable.

The BABOON properly so called is from three to four feet high, very strong built with a thick body and limbs and canine teeth much longer than those of men. It has large callosities behind which are quite naked and red. Its tail is crooked and thick and about seven or eight inches long. Its snout for it can hardly be called a face is long and thick and on each side of its cheeks it has a pouch into which when satiated with eating it puts the remainder of its provisions. It is covered with long thick hair of a reddish brown colour and pretty uniform over the whole body. It walks more commonly upon all fours than upright and its hands as well as its feet are armed with long sharp claws instead of the broad round nails of the ape kind.

An animal thus made for strength and furnished with dangerous weapons is found in fact, to be one of the most formidable of the savage race in those countries where it is bred. It appears in its native woods to be impelled by two opposite passions, a hatred for the males of the human species and a desire for women. Were we assured of these strange oppositions in its disposition from one testimony alone the account might appear doubtful but as it comes from a variety of the most credible witnesses we cannot refuse our assent. From them therefore we learn that these animals will often assail women in a body and force them

into the woods, where they keep them against their will, and kill them when refractory. From the Chevalier Forbin we learn, that in Siam whole troops of these will often sally forth from their forests, and attack a village, when they know the men are engaged in their rice harvest. They are on such occasions actuated as well by desire as by hunger, and not only plunder the houses of whatever provisions they can find, but endeavour to force the women. These, however, as the Chevalier humorously relates, not at all liking either the manners or the figure of the paltry gallants, boldly stand on their defence, and with clubs, or whatever other arms they can provide, instead of answering their caresses, oblige their ugly visitors to retreat; not, however, before they have damaged or plundered every thing eatable they can lay their hands on.

At the Cape of Good Hope, they are less formidable, but, to the best of their power, equally mischievous. They are there under a sort of natural discipline, and go about whatever they undertake with surprising skill and regularity. When they set about robbing an orchard or a vineyard, for they are extremely fond of grapes, apples, and ripe fruit, they do not go singly to work, but in large companies, and with preconcerted deliberation. On these occasions, a part of them enter the enclosure, while one is set to watch. The rest stand without the fence, and form a line reaching all the way from their fellows within, to their rendezvous without, which is generally in some craggy mountain. Every thing being thus disposed, the plunderers within the orchard throw the fruit to those that are without as fast as they can gather it, or, if the wall or hedge be high, to those that sit on the top; and these hand the plunder to those next them on the other side. Thus the fruit is pitched from one to another all along the line, till it is safely deposited at their head-quarters. They catch it as readily as the most skilful tennis-player can a ball; and while the business is going forward, which they conduct with great expedition, a most profound silence is observed among them. Their sentinel, during this whole time, continues upon the watch, extremely anxious and attentive; but, if he perceives any one coming, he instantly sets up a loud cry, and at this signal the whole company scamper off. Not yet are they at any time willing to leave the place

empty handed for if they be plundering a bed of melons for instance they go off with one in their mouths one in their hands and one under their arm If the pursuit is hot they drop first that from under their arm then that from their hand and if it be continued they at last let fall that which they had hitherto kept in their mouths

The natives of the Cape often take the young of these animals and feeding them with sheep and goats milk accustom them to guard their houses which duty they perform with great punctuality Those however that have been brought into Europe are headstrong rude and untractable Dogs and cats when they have done any thing wrong will run off but these seem careless and insensible of the mischief they do and I have seen one of them break a whole table of china as it should seem by design without appearing in the least conscious of having done amiss It was not however in any respect so formidable as that described by Mr Buffon of which he gives the following description — It was not says he extremely ugly and yet it excited horror It continually appeared in a state of savage ferocity gnashing its teeth flying at the spectators and furiously restless It was obliged to be confined in an iron cage the bars of which it so forcibly attempted to break that the spectators were struck with apprehension It was a sturdy bold animal whose short limbs and powerful exertions shewed vast strength and agility The long hair with which it was covered seemed to add to its apparent abilities which however were in reality so great that it could easily overcome a single man unless armed As to the rest it for ever appeared excited by that passion which renders the mildest animals at intervals furious Its lasciviousness was constant and its satisfactions particular Some others also of the monkey kind shewed the same degree of impudence and particularly in the presence of women but as they were less in size their petulance was less obvious and their insolence more easily corrected

But however violent the desires of these animals may be they are not found to breed in our climate The female brings forth usually but one at a time which she carries in her arms and in a peculiar manner clinging to her breast As to the rest these animals are not at all carnivorous,

they principally feed upon fruits, roots, and corn, and generally keep together in companies. The internal parts are more unlike those of man than of quadrupeds, particularly the liver, which is, like that of a dog, divided into six lobes. The lungs are more divided, the guts in general are shorter, and the kidneys rounder and flatter.

The largest of the baboon kind is the **MANDRIL**, an ugly disgusting animal, with a tail shorter than the former, though of a much larger stature, being from four to five feet high. The muzzle is still longer than that of the preceding, it is of a bluish colour, and strongly marked with wrinkles, which give it a frightful appearance. But what renders it truly loathsome is, that from the nose there is always seen issuing a snot, which the animal takes care at intervals to lick off with its tongue, and swallow. It is a native of the Gold Coast, it is said to walk more frequently erect than upon all-fours, and, when displeased, to weep like a child. There was one of them shown in England some years ago. It seemed tame, but stupid, and had a method of opening its mouth and blowing at such as came too near.

The **WANDERLAW** is a baboon rather less than the former, with the body less compact and muscular, and the hinder parts seemingly more feeble. The tail is from seven to eight inches long, the muzzle is prominent, as in the rest of this kind, but what particularly distinguishes it, is a large long white head of hair, together with a monstrous white beard, coarse, rough, and descending, the colour of the rest of the body being brown or black. As to the rest, in its savage state, it is equally fierce with the others, but, with a proper education, it seems more tractable than most of its kind, and is chiefly seen in the woods of Ceylon and Malabar.

The **MAIMON** of Buffon, which Edwards calls the **PIGTAIL**, is the last of the baboons, and in size rather approaches the monkey, being no larger than a cat. Its chief distinction, besides its prominent muzzle, like a baboon, is in the tail, which is about five or six inches long, and curled up like that of a hog, from which circumstance, peculiar to this animal, our English naturalist gave it the name. It is a native of Sumatra, and does not well endure the rigours of our climate. Edwards, however, kept one of them a year in

London and another of them happening at the same time to be exposed in a show of beasts he brought the two together to see if they would chum or acknowledge kindred. The moment they came into each other's sight they testified their mutual satisfaction and quite transported at the interview.

THE MONKEY

THE varieties in the larger tribes of the monkey are but few, in the ape we have seen but four and baboon about as many. But when we come to the class the differences among them seem too tedious to enumerate. These as was observed in the beginning are all small in stature and with long tails by which they are distinguished from the preceding that entirely want a tail or are large and have but a short one. The variety in the form and colour of dogs, or squirrels is not what are found among monkeys of the smaller kind. Linnaeus mentions above fifty sorts on the Gold Coast and Smith confirms the account. Condamine asserts it would take up a volume to describe the differences of these to be found along the river Amazons and is quite sure that every one of these is very different from the others of the African coast. Naturalists however have undertaken to make a catalogue of their numbers and they transmit their descriptions from one to another and enumerate those few that have found their way to Europe and have fallen within the narrow circle of their observation. But though it may be proper enough to describe such as fall under notice it is certainly wrong to offer a scanty catalogue as complete and to induce the reader to suppose he sees a picture of the whole genus of these animals when he is only presented with a small number. Such therefore as are fond of the gratification of adding new descriptions to the stock of natural history have here a wide though surely a barren field to enlarge in and they will find it no difficult matter in serving the various animals of this kind that are from time to time brought from their native coasts to this country to indulge in description and to ring the changes upon the technical terms with which this most pleasing

is obscured and rendered disgusting For my own part, I will spare the reader and myself the trouble of entering into an elaborate description of each, content with observing once more, that their numbers are very great, and their differences very trifling There is scarcely a country in the tropical climates that does not swarm with them, and scarcely a forest that is not inhabited by a race of monkeys distinct from all others Every different wood along the coasts of Africa may be considered as a separate colony of monkeys, differing from those of the next district in colour, in size, and malicious mischief It is indeed remarkable, that the monkeys of two cantons are never found to mix with each other, but rigorously to observe a separation each forest produces only its own, and these guard their limits from the intrusion of all strangers of a different race from themselves In this they somewhat resemble the human inhabitants of the savage nations among whom they are found, where the petty kingdoms are numerous, and their manners opposite There, in the extent of a few miles, the traveller is presented with men speaking different languages, professing different religions, governed by different laws, and only resembling each other in their mutual animosity

In general, monkeys of all kinds, being less than the baboon, are endued with less powers of doing mischief Indeed, the ferocity of their nature seems to diminish with their size, and when taken wild in the woods, they are sooner tamed, and more easily taught to imitate man, than the former More gentle than the baboon, and less grave and sullen than the ape, they soon begin to exert all their sportive mimeries, and are easily restrained by correction But it must be confessed that they will do nothing they are desir'd without beating, for, if their fears be entirely removed, they are the most insolent and headstrong animals in nature

In their native woods they are not less the pests of man than of other animals The monkeys, says a traveller,* are in possession of every forest where they reside, and may be considered as the masters of the place Neither the tiger, nor the lion itself, will venture to dispute the dominion, since these, from the tops of trees, continually carry on

* Description Historique de Macacar, p 51

offensive war and by their agility escape all possibility of pursuit. Nor have the birds less to fear from their continual depredations for as these harmless inhabitants of the wood usually build upon trees the monkeys are for ever on the watch to find out and rob their nests and such is their petulant delight in mischief that they will fling their eggs against the ground when they want appetite or inclination to devour them.

There is but one animal in all the forest that ventures to oppose the monkey and that is the serpent. The larger snakes are often seen winding up the trees where the monkeys reside, and when they happen to surprise them sleeping swallow them whole before the little animals have time to make a defence. In this manner the two most mischievous kinds in all nature keep the whole forest between them both equally formidable to each other and for ever employed in mutual hostilities. The monkeys in general inhabit the tops of the trees and the serpents cling to the branches nearer the bottom and in this manner they are for ever seen near each other like enemies in the same field of battle. Some travellers indeed have supposed that their vicinity rather argued their mutual friendship and that they united in this manner to form an offensive league against all the rest of animated nature *. I have seen these monkeys says Labat playing their gambols upon those very branches on which the snakes were reposing and jumping over them without receiving any injury although the serpents of that country were naturally vindictive and always ready to bite whatever disturbed them. These gambols however were probably nothing more than the insults of an enemy that was conscious of its own safety and the monkeys might have provoked the snake in the same manner as we often see sparrows twitter at a cat. However this be the forest is generally divided between them and these woods which nature seems to have embellished with her richest magnificence rather inspire terror than delight and chiefly serve as retreats for mischief and malignity.

The enmity of these animals to mankind is partly ridiculous and partly formidable. They seem says Le Compte and others to have a peculiar instinct in discovering their

* Labat Relat de l'Afrique Occident p 317

foes, and are perfectly skilled, when attacked, in mutually defending and assisting each other. When a traveller enters among these woods, they consider him as an invader upon their dominions, and all join to repel the intrusion. At first they survey him with a kind of insolent curiosity. They jump from branch to branch, pursue him as he goes along, and make a loud clattering, to call the rest of their companions together. They begin their hostilities by grinning, threatening, and flinging down the withered branches at him, which they break from the trees, they even take their excrements in their hands, and throw them at his head. Thus they attend him wherever he goes, jumping from tree to tree with such amazing swiftness, that the eye can scarcely attend their motions. Although they take the most desperate leaps, yet they are seldom seen to come to the ground, for they easily fasten upon the branches that break their fall, and stick, either by their hands, feet, or tail, wherever they touch. If one of them happens to be wounded, the rest assemble round, and clap their fingers into the wound, as if they were desirous of sounding its depth. If the blood flows in any quantity, some of them keep it shut up, while others get leaves, which they chew, and thrust into the opening: however extraordinary this may appear, it is asserted to be often seen, and to be strictly true. In this manner they wage a petulant, unequal war, and are often killed in numbers before they think proper to make a retreat. This they effect with the same precipitation with which they at first came together. In this retreat the young are seen clinging to the back of the female, with which she jumps away, seemingly unembarrassed by the burden.

The curiosity of the Europeans has, in some measure, induced the natives of the places where these animals reside to catch or take them alive by every art they are able. The usual way in such case is to shoot the female as she carries her young, and then both, of course, tumble to the ground. But even this is not easily performed, for if the animal be not killed outright it will not fall; but clinging to some branch, continues, even when dead, its former grasp, and remains on the tree where it was shot until it drops off by putrefaction. In this manner it is totally lost to the pursuer, for to attempt climbing the tree, to bring either it or the young one down, would probably be fatal, from the number of

serpents that are hid among the branches. For this reason the sportsman always takes care to aim at the head which if he hits the monkey falls directly to the ground and the young one comes down at the same time clinging to its dead parent.

The Europeans along the coasts of Guinea often go into the woods to shoot monkeys and nothing pleases the negroes more than to see those animals drop against which they have the greatest animosity. They consider them and not without reason as the most mischievous and tormenting creatures in the world and are happy to see their numbers destroyed upon a double account as well because they dread their devastations as because they love their flesh. The monkey which is always skinned before it is eaten when served up at a negro feast looks so like a child that an European is shocked at the very sight. The natives however who are not so nice devour it as one of the highest delicacies and assiduously attend our sportsmen to profit by the spoil. But what they are chiefly astonished at is to see our travellers carefully taking the young ones alive while they leave them the old ones that are certainly the most fit to be eaten. They cannot comprehend what advantage can arise to us from educating or keeping a little animal that by experience they know to be equally fraught with tricks and mischief some of them have even been led to suppose that with a kind of perverse affection we love only creatures of the most mischievous kinds and having seen us often buy young and tame monkeys they have taken equal care to bring rats to our factors offering them for sale and greatly disappointed at finding no purchaser for so hopeful a commodity *

The negroes consider these animals as their greatest plague and indeed they do incredible damage when they come in companies to lay waste a field of Indian corn or rice or a plantation of sugar canes. They carry off as much as they are able and they destroy ten times more than they bear away. Their manner of plundering is pretty much like that of the baboons already mentioned in a garden. One of them stands sentinel upon a tree while the rest are plundering carefully and cautiously turning on every side

but particularly to that on which there is the greatest danger in the mean time, the rest of the spoilers pursue their work with great silence and assiduity, they are not contented with the first blade of corn, or the first cane that they happen to lay their hands on, they first pull up such as appear most alluring to the eye, they turn it round, examine, compare it with others, and if they find it to their mind, stick it under one of their shoulders. When in this manner they have got their load, they begin to think of retreating but if it should happen that the owners of the field appear to interrupt their depredations, their faithful sentinel instantly give notice by crying out, *Houp, houp, houp* ' which the rest perfectly understand, and all at once throwing down the corn they hold in their left hands, scamper off upon three legs, carrying the remainder in the right. If they are still hotly pursued, they then are content to throw down their whole burden, and to take refuge among their woods, on the tops of which they remain in perfect security.

Were we to give faith to what some travellers assure us, of the government, policies, and subordination of these animals, we might perhaps be taxed with credulity, but we have no reason to doubt that they are under a kind of discipline, which they exercise among each other. They are generally seen to keep together in companies, to march in exact order, and to obey the voice of some particular chieftain, remarkable for his size and gravity. One species of these, which M^r. Buffon calls the OUARINE, and which are remarkable for the loudness and the distinctness of their voice, are still more so for the use to which they convert it. "I have frequently been a witness," says Margrave, "of their assemblies and deliberations. Every day, both morning and evening, the ouarines assemble in the woods to receive instructions. When all come together, one among the number takes the highest place on a tree, and makes a signal with his hand to the rest to sit round, in order to hearken. As soon as he sees them placed, he begins his discourse, with so loud a voice, and yet in a manner so precipitate, that, to hear him at a distance, one would think the whole company were crying out at the same time. However, during that time, one only is speaking, and all the rest observe the most profound silence

When this has done, he makes a sign with the hand for the rest to reply and at that instant they raise their voices together until by another signal of the hand they are enjoined silence. This they as readily obey till at last the whole assembly breaks up after hearing a repetition of the same preachingment.

The chief food of the monkey tribe is fruits the buds of trees or succulent roots and plants. They all like man seem fond of sweets and particularly the pleasant juice of the palm tree and the sugar cane. With these the fertile regions in which they are bred seldom fail to supply them, but when it happens that these fail or that more nourishing food becomes more agreeable they eat insects and worms and sometimes if near the coasts descend to the sea shore where they eat oysters crabs and shell fish. Their manner of managing an oyster is extraordinary enough, but it is too well attested to fail of our assent. As the oysters in the tropical climates are generally larger than with us the monkeys when they go to the sea side pick up a stone and clap it between the opening shells, thus prevents them from closing and the monkey then eats the fish at his ease. They often also draw crabs from the water by putting their tail to the hole where that animal takes refuge and the crab fastening upon it they withdraw it with a jerk and thus pull their prey upon shore. This habit of laying traps for other animals makes them very cautious of being entrapped themselves and I am assured by many persons of credit that no snare how nicely baited soever will take the monkey of the West India islands for having been accustomed to the cunning of man it opposes its natural distrust to human artifice.

The monkey generally brings forth one at a time and sometimes two. They are rarely found to breed when brought over into Europe but of those that do they exhibit a very striking picture of parental affection. The male and female are never tired of fondling their young one. They instruct it with no little assiduity and often severely correct it if stubborn or disinclined to profit by their example. They hand it from one to the other and when the male has done shewing his regard the female takes her turn. When wild in the woods the female if she happens to have two, carries one on her back and the other

in her arms • that on her back clings very closely, clasping its hands round her neck, and its feet about her middle : when she wants to suckle it, she then alters their position ; and that which has been fed gives place to the other, which she takes in her arms It often happens that she is unable to leap from one tree to another, when thus loaden ; and upon such occasions then dexterity is very surprising. The whole family form a kind of chain, locking tail in tail, or hand in hand, and one of them holding the branch above, the rest swing down, balancing to and fro, like a pendulum, until the undermost is enabled to catch hold of the lower branches of some neighbouring tree When the hold is fixed below, the monkey lets go that which was above, and thus comes undermost in turn ; but, creeping up along the chain, attains the next branches, like the rest ; and thus they all take possession of the tree, without ever coming to the ground

When in a state of domestic tameness, those animals are very amusing, and often fill up a vacant hour, when other entertainment is wanting There are few that are not acquainted with their various mimics, and their capricious feats of activity But it is generally in company with other animals of a more simple disposition that their tricks and superior instincts are shown ; they seem to take a delight in tormenting them , and I have seen one of them amusing itself for hours together, in imposing upon the gravity of a cat Erasmus tells us of a large monkey, kept by Sir Thomas More, that, one day diverting itself in his garden, where some tame rabbits were kept, played several of its usual pranks among them, while the rabbits scarcely well knew what to make of their new acquaintance in the mean time, a weasel, that came for very different purposes than those of entertainment, was seen peering about the place in which the rabbits were fed, and endeavouring to make its way, by removing a board that closed their hutch While the monkey saw no danger, it continued a calm spectator of the enemy's effort ; but just when, by long labour, the weasel had effected its purpose, and had removed the board, the monkey stepped in, and, with the utmost dexterity, fastened it again in its place, and the disappointed weasel was too much fatigued to renew its operations. To this I will only add what Father Carl, in

his history of Angola assures us to be true. In that horrid country where he went to convert the savage natives to Christianity and met with nothing but distress and disappointment while his health was totally impaired by the raging heats of the climate his patience exhausted by the obstinacy of the stupid natives and his little provisions daily plundered without redress in such an exigency he found more faithful services from the monkeys than the men these he had taught to attend him to guard him whilst sleeping against thieves and rats to comb his head to fetch his water and he asserts that they were even more tractable than the human inhabitants of the place. It is indeed remarkable that in those countries where the men are most barbarous and stupid the brutes are most active and sagacious. It is in the torrid tracts inhabited by barbarians that such various animals are found with instinct so near to that of man as both of Africa and Asia to be men idle and conversant in labour.

As of all savages those of Africa are the most brutal so of all countries the monkeys of Africa are the most expert and entertaining. The monkeys of America are in general neither so sagacious nor so tractable nor is their form so nearly approaching that of man. The monkeys of the new continent may be very easily distinguished from those of the old by three marks. Those of the ancient continent are universally found to have a naked callous substance behind upon which they sit which those of America are entirely without those also of the ancient continent have the nostrils differently formed more resembling those of men the holes opening downward whereas the American monkeys have them opening on each side those of the ancient world have pouches on each side the jaw into which they put their provisions which those of America are without lastly none of the monkeys of the ancient continent hang by the tail which many of the American sorts are known to do. By these marks the monkeys of either continent may be readily distinguished from each other and prized accordingly. The African monkey as I am assured requires a longer education and more cor-

rection, than that of America; but it is at last found capable of more various powers of imitation, and shews a greater degree of cunning and activity.

Mr Buffon, who has examined this race of imitative beings with greater accuracy than any other naturalist before him, makes but nine species of monkeys belonging to the ancient continent; and eleven belonging to the new. To all these he gives the names which they go by in their respective countries; which, undoubtedly, is the method least liable to error, and the most proper for imitation.

Of the monkeys of the ancient continent, the first he describes is the *MACAGUO*; somewhat resembling a baboon in size, strength of body, and a hideous wrinkled visage. it differs, however, in having a very long tail, which is covered with tufted hair. It is a native of Congo.

The second is the *PATAS*, which is about the same size with the former; but differs in having a longer body, and a face less hideous. it is particularly remarkable for the colour of his hair, which is of a red, so brilliant, that the animal looks as if it were actually painted. It is usually brought from Senegal, and by some called the *red African monkey*.

The third of the ancient continent is the *MALBROUK*, of which he supposes the monkey which he calls the *BONET CHINOIS* to be a variety. The one is remarkable for a long tail, and long beard; the other, for a cap of hair that covers the crown of the head, from whence it takes the name. Both are natives of the East Indies, and the Bramins, who extend their charity to all the brute creation, have hospitals for such of them as happen to be sick, or otherwise disabled.

The fourth of this kind is the *MANGABEY*, it may be distinguished from all others by its eye-lids, which are naked, and of a striking whiteness. It is a native of Madagascar.

The fifth is the *MONA*, or the *CEPHUS* of the ancients: it is distinguished by its colour, which is variegated with black and red, and its tail is of an ash colour, with two white spots on each side at its insertion. It is a native of the northern parts of Africa.

The sixth is the *CALLITRIX*, or *GREEN MONKEY* of St Iago; distinguished by its beautiful green colour on the back, its white breast and belly, and its black face.

The seventh is the MOUSTOC or WHITE NOSE distinguished by the whiteness of its lips from whence it has received its name the rest of the face being of a deep blue It is a native of the Gold Coast, and a very beautiful little animal

The eighth is the TALAPOIN, and may be distinguished as well by its beautiful variety of green white and yellow hair as by that under the eyes being of a greater length than the rest. It is supposed to be a native of Africa and the East

The ninth and last of the monkeys of the ancient continent, is the DOUC so called in Cochinchina of which country it is a native The douc seems to unite the characters of all the former together with a long tail like the monkey of a size as large as the baboon and with a flat face like the ape it even resembles the American monkeys in having no callosity on its posteriors Thus it seems to form the shade by which the monkeys of one continent are linked with those of the other

Next come the monkeys of the new continent which as has been said differ from those of the old in the make of their nostrils in their having no callosity on their posteriors and in their having no pouches on each side of the jaw They differ also from each other a part of them making no use of their tails to hang by while others of them have the tail very strong and muscular and serving by way of a fifth hand to hold by Those with muscular holding tails are called SAPAJOUS those with feeble useless tails are called SAGOINS Of the sapajous there are five sorts of the sagoins there are six

The first of the sapajous is the WARINE or the BRAZILIAN GUARIBA This monkey is as large as a fox with black long hair and remarkable for the loudness of its voice It is the largest of the monkey kind to be found in America

The second is the COATI which may be distinguished from the rest by having no thumb and consequently but four fingers on the two fore paws The tail however supplies the defects of the hand and with this the animal slings itself from one tree to another with surprising rapidity

The third is the SAJOU distinguished from the rest of the sapajous by its yellowish flesh coloured face

The fourth is the *SAI*. It is somewhat larger than the *sajou*, and has a broader muzzle. It is called also the *BEWAILER*, from its peculiar manner of lamenting when either threatened or beaten.

The fifth and last of the *sapajou* kind, or monkeys that hold by the tail, is the *SAMARI*, or *AURORA*; which is the smallest and most beautiful of all. It is of a fine orange colour, with two circles of flesh round the eyes. It is a very tender, delicate animal, and held in high price.

Of the *sagoins* with feeble tails there are six kinds. The first and the largest is the *SAKI*, or *CAGUI*; so remarkable for the length of the hair on its tail, that it has been often termed the *FOX-TAILED MONKEY*. It is of different sizes; some being twice as large as others.

The second of this kind is the *TAMAIN*; which is usually black, with the feet yellow. Some, however, are found all over brown, spotted with yellow.

The third is the *WISTITI*; remarkable for the large tufts of hair upon its face, and its annulated tail.

The fourth is the *MARIKINA*; with a mane round the neck, and a bunch of hair at the end of the tail, like a lion.

The fifth is called the *PINCH*; with the face of a beautiful black, and white hair that descends on each side of the face, like that of man.

The last, least, and most beautiful of all, is the *MICO*, an animal too curiously adorned not to demand a particular description; which is thus given of it by Mr. Condamine — “That,” says he, “which the governor of Para made me a present of, was the only one of its kind that was seen in the country. The hair on its body was of a beautiful silver colour, brighter than that of the most venerable human hair; while the tail was of a deep brown, inclining to blackness. It had another singularity more remarkable than the former; its ears, its cheeks, and lips, were tinged with so bright a vermilion, that one could scarcely be led to suppose that it was natural. I kept it a year; and it was still alive when I made this description of it, almost within sight of the coasts of France. all I could then do was to preserve it in spirits of wine, which might serve to keep it in such a state as to shew that I did not in the least exaggerate in my description.”

OF THE MAKI

THE last of the monkey kind are the makies, which have no other pretensions to be placed in this class except that of having hands like the former and making use of them to climb trees or to pluck their food. Animals of the hare kind indeed are often seen to feed themselves with their fore paws but they can hold nothing in one of them singly and are obliged to take up whatever they eat in both at once but it is otherwise with the maki as well as the monkey kinds they seize their food with one hand pretty much like a man and grasp it with great ease and firmness. The maki therefore from this conformation in its hands both before and behind approaches nearly to the monkey kind but in other respects such as the make of the snout the form of the ears and the parts that distinguish the sexes it entirely differs from them. There are many different kinds of these animals all varying from each other in colour or size but agreeing in the human like figure of their hands and feet and in their long nose which somewhat resembles that of a dog. As most of these are bred in the depths of the forest, we know little more concerning them than their figure. Their way of living their power of pursuit and escape can only be supposed from the analogy of their conformation somewhat to resemble those of the monkey.

The first of this kind is the *nococo* a beautiful animal about the size of a common cat but the body and limbs slenderer and of a longer make. It has a very long tail at least double the length of its body it is covered with fur and marked alternately with broad rings of black and white. But what it is chiefly remarkable for besides the form of its hands and feet is the largeness of its eyes which are surrounded with a broad black space and the length of the hinder legs which by far exceed those before. When it sleeps it brings its nose to its belly and its tail over its head. When it plays it uses a sort of galloping with its tail raised over its back which keeps continually in motion. The head is covered with dark ash coloured hair the back and sides with a red ash colour and not so dark as on the head and the whole glossy, soft and delicate smooth to the touch and standing almost upright like the pile of velvet.

It is a native of Madagascar, appears to be a harmless gentle animal, and though it resembles the monkey in many respects, yet it has neither its malice nor its mischief. nevertheless, like the monkey, it seems to be always in motion; and moves, like all four-handed animals, in an oblique direction

A second of this kind, which is also a native of Madagascar, is the MONGOZ; which is less than the former, with a soft glossy robe, but a little curled. The nose also is thicker than that of the mococo, the eyes are black, with orange-coloured circles round the pupil, and the tail is of one uniform colour. As to the rest, it is found of various colours; some being black, others brown; and its actions somewhat resemble those of a monkey

The VARI is much larger than either of the former; its hair is much longer, and it has a kind of ruff round the neck, consisting of very long hair, by which it may be easily distinguished from the rest. It differs also in its disposition, which is fierce and savage, as also in the loudness of its voice, which somewhat resembles the roaring of the lion. This also is a native of Madagascar

To this tribe we may refer a little four-handed animal, of the island of Ceylon, which Mr. Buffon calls the LORI; very remarkable for the singularity of its figure. This is, of all other animals, the longest in proportion to its size; having nine vertebræ in the loins; whereas other quadrupeds have only seven*. The body appears still the longer by having no tail. In other respects, it resembles those of the Maki kind; as well in its hands and feet, as in its snout, and in the glossy qualities of its hair. It is about the size of a squirrel; and appears to be a tame, harmless little animal.

OF THE OPPOSSUM, AND ITS KINDS

To these four-handed animals of the ancient continent, we may add the four-handed animals of the new, that use their hands like the former, as well as their tails, and that fill up the chasm between the monkey tribe and the lower orders of the forest. As the Maki kind, in some measure,

* Buffon, vol. xxi p 274

seem to unite the fox and the monkey in their figure and size so these seem to unite the monkey and the rat. They are all less than the former they have long tails almost bare of hair, and their fur as well as their shape seems to place them near the rat kind. Some have accordingly ranked them in that class but their being four handed is a sufficient reason for placing them in the rear of the monkeys.

The first, and the most remarkable of this tribe is the *OROSSUM* an animal found both in North and South America of the size of a small cat. The head resembles that of a fox it has fifty teeth in all but two great ones in the midst like those of a rat. The eyes are little round clearly and placed upright the ears are long broad and transparent, like those of the rat kind, its tail also increases the similitude being round long a little hairy in the beginning but quite naked towards the end. The fore legs are short being about three inches long while those behind are about four. The feet are like hands each having five toes or fingers with white crooked nails and rather longer behind than before. But it is particular in this animal that the thumb on the hinder legs wants a nail whereas the fingers are furnished with clawed nails as usual.

But that which distinguishes this animal from all others and what has excited the wonder of mankind for more than two centuries is the extraordinary conformation of its belly as it is found to have a false womb into which the young when brought forth in the usual manner creep and continue for some days longer to lodge and suckle securely. This bag if we may so call it being one of the most extraordinary things in natural history requires a more minute description. Under the belly of the female is a kind of slit or opening of about three inches long, this opening is composed of a skin which makes a bag internally that is covered on the inside with hair and in this bag are the teats of the female and into it the young when brought forth retire either to suckle or to escape from danger. This bag has a power of opening and shutting at the will of the animal and this is performed by means of several muscles and two bones that are fitted for this purpose and that are peculiar to this animal only. These bones are placed before the

os pubis, to which they are joined at the base; they are about two inches long, and grow smaller and smaller to their extremities. These support the muscles that serve to open the bag, and give them a fixture. To these muscles there are antagonists, that serve in the same manner to shut the bag; and this they perform so exactly, that in the living animal the opening can scarcely be discerned, except when the sides are forcibly drawn asunder. The inside of this bag is furnished with glands that exude a musky substance, which communicates to the flesh of the animal, and renders it unfit to be eaten. It is not to be supposed that this is the place where the young are conceived, as some have been led to imagine; for the opossum has another womb, like that of the generality of animals, in which generation is performed in the ordinary manner. The bag we have been describing may rather be considered as a supplemental womb. In the real womb, the little animal is partly brought to perfection; in the ordinary one, it receives a kind of additional incubation; and acquires, at last, strength enough to follow the dam wherever she goes. We have many reasons to suppose that the young of this animal are all brought forth prematurely, or before they have acquired that degree of perfection which is common in other quadrupeds. The little ones, when first produced, are in a manner but half completed; and some travellers assert, that they are at that time not much larger than flies. We are assured also, that immediately on quitting the real womb they creep into the false one, where they continue fixed to the teat, until they have strength sufficient to venture once more into the open air, and share the fatigues of the parent. Ulloa assures us, that he has found five of these little creatures hidden in the belly of the dam three days after she was dead, still alive, and all clinging to the teat with great avidity. It is probable, therefore, that upon their first entering the false womb, they seldom stir out from thence, but when more advanced, they venture forth several times in the day, and at last seldom make use of their retreat, except in cases of necessity or danger. Travellers are not agreed in their accounts of the time which these animals take to continue in the false womb; some assure us they remain there for several weeks; and others, more precisely, mention a month. During this period of strange gestation there is no difficulty

in opening the bag in which they are concealed they may be reckoned examined and handled, without much inconvenience for they keep fixed to the tent and cling there as firm as if they made a part of the body of the animal that bears them. When they are grown stronger, they drop from the tent into the bag in which they are contained, and at last find their way out in search of more copious subsistence. Still however the false belly serves them for a retreat either when they want to sleep or to suckle or when they are pursued by an enemy. The dam on such occasions opens her bag to receive them which they enter

—Pars formidine turpi
Scandunt rursus equum et nota conduntur in alia

The opossum when on the ground is a slow helpless animal the formation of its hands are alone sufficient to shew its incapacity of running with any degree of swiftness but to counterbalance this inconvenience, it climbs trees with great ease and expedition*. It chiefly subsists upon birds and hides among the leaves of the trees to seize them by surprise. It often also hangs by the tail which is long and muscular and in this situation for hours together with the head downwards it keeps watching for its prey. If any lesser animal which it is able to overcome passes under neath it drops upon it with deadly aim and quickly devours it. By means of its tail the opossum also slings from one tree to another, hunts insects escapes its pursuers and provides for its safety. It seems to be a creature that lives upon vegetables as well as animal substances roots sugar canes the bark and even the leaves of trees. It is easily tamed but it is a disagreeable domestic as well from its stupidity and figure as its scent which however fragrant in small quantities fails not to be ungrateful when copiously supplied.

An animal greatly resembling the former † is the MAR MOSE which is found in the same continent. It seems only to differ in size being less and instead of a bag to receive its young has only two longitudinal folds near the thighs within which the young which are prematurely brought

* Buffon vol. xxi p. 174

† Buffon vol. xxi p. 110

forth, as in the last instance, continue to suckle. The young of these, when first produced, are not above the size of a bean; but continue sticking to the teat, until they have arrived at greater maturity.

The *CAYOPOLES* is somewhat larger than the former, and a good deal resembling it in habits and figure, except that its snout is more pointed, its tail longer in proportion, and its colour different, being of an ash, somewhat inclining to yellow; however, I should suppose it to be only a variety of the former.

To this number we may add the *PHILANGER*, so called by Mr. Buffon: a good deal resembling the former, but distinguished by the fashion of its hinder hands; the thumb and fore-finger being joined together, except at the extremities. This animal is about the size of a rat, and has, accordingly, by some, been called the *RAT OF SURINAM*.

The last animal of this class is called, by Mr. Buffon, the *PARILR*. This extraordinary little animal resembles the former, in having four hands, and a long tail, but it differs very much in the extreme length of its hinder legs, which are longer than the rest of its whole body. The bones of that part of the foot called the *tarsus*, are likewise so very long, that from thence the animal has received its name: the tail is naked in the middle, and hairy only at both extremities: its hair is woolly, soft, and of a deep ash-colour. As to the rest, it is unknown from what country this animal was brought; but the naturalist from whom we have its description, supposes it to be a native of America.

From this general description of four-handed animals, we perceive what few advantages the brute creation derive from those organs, that, in man, are employed to so many great and useful purposes. The being able to pluck their food from the trees, the capacity of clinging among the branches, and at most of converting one of those branches into a weapon of offence, are the highest stretches of their sagacity, and the only use their hands have hitherto been employed in, and yet some superficial men have asserted, that the hands alone are sufficient to vindicate the dominion of mankind over other animals, and that much of his boasted reason, is nothing more than the result of his happier conformation: however, were this so, an ape or a monkey would, in some instances, be more rational than we, their fingers

are smaller and in some of them more finely formed than ours. To what a variety of purposes might they not be employed if their powers were properly exerted? Those works which we from the largeness of our fingers are obliged to go clumsily about, one of these could very easily perform with the utmost exactness and if the fineness of the hand assisted reason an ape would be one of the most reasonable beings in the creation. But these admirably formed machines are almost useless both to mankind and themselves, and contribute little more to the happiness of animal life than the paws of the lowest quadruped. They are supplied in deed with the organs but they want the mind to put them into action it is that reasoning principle alone with which man has been endowed that can adapt seemingly opposite causes to concur in the same general design and even where the organs are deficient that can supply their place by the intervention of assisting instruments. Where reason prevails we find that it scarcely matters what the organs are that give it the direction the being furnished with that principle still goes forward steadily and uniformly successful breaks through every obstacle and becomes master of every enterprise. I have seen a man without hands or legs convert by practice his very stumps to the most convenient purposes and with these clumsy instruments perform the most astonishing feats of dexterity. We may therefore conclude that it is the mind alone that gives a master to the creation and that if a bear or a horse were endowed with the same intellects that have been given to man the hardness of a hoof or the awkwardness of a paw would be no obstacle to their advancement in the arts of dominion or of social felicity.

Nearly allied to the last kind in having a pouch for the security of its young but differing in many other particulars is the *Kangaroo* a native of New Holland first discovered by Captain Cook in the year 1770. Its size is at least that of a full grown sheep but there is a remarkable disproportion in its shape the head and neck being very small while the lower parts gradually dilate to a very great size the fore legs are hardly nineteen inches long while the hinder ones measure three feet nine inches accordingly this animal is composed of vast springs or bound

tail is of

gle bl w

one at a time) at first hardly exceed an inch in length and in the early periods of their growth reside entirely within the pouch of the dam

CHAP. II.

OF THE ELEPHANT

HAVING gone through the description of those quadrupeds that, by resembling each other in some striking particular, admit of being grouped together, and considered under one point of view, we now come to those insulated sorts that bear no similitude with the rest, and that to be distinctly described must be separately considered.

The foremost of these, and in every respect the noblest quadruped in nature, is the Elephant, not less remarkable for its size than its docility and understanding. All historians concur in giving it the character of the most sagacious animal next to man, and yet, were we to take our idea of its capacity from its outward appearance, we should be led to conceive very meanly of its abilities. The elephant, at first view, presents the spectator with an enormous mass of flesh that seems scarcely animated. Its huge body, covered with a callous hide, without hair, its large mis-shapen legs, that seem scarcely formed for motion, its little eyes, large ears, and long trunk, all give it an air of extreme stupidity. But our prejudices will soon subside when we come to examine its history, they will even serve to increase our surprise, when we consider the various advantages it derives from so clumsy a conformation.

The elephant is seen from seven to no less than fifteen feet high. Whatever care we take to imagine a large animal before-hand, yet the first sight of this huge creature never fails to strike us with astonishment, and in some measure to exceed our idea. Having been used to smaller animals, we have scarcely any conception of its magnitude; for a moving column of flesh, fourteen feet high, is an object so utterly different from those we are constantly presented with, that to be conceived it must be actually seen. Such, I own, were the suggestions that naturally arose to me when I first saw this animal, and yet for the sight of which I had taken care to prepare my imagination. I found my ideas fall as

They feed on vegetables, drink by lapping, and burrow under ground. The Rat Kangaroo differs from the above, being only about the size of a rabbit, and is far less elegant and pleasing.]

short of its real size as they did of its real figure neither the pictures I had seen nor the descriptions I had read giving me adequate conceptions of either

It would therefore be impossible to give an idea of this animal's figure by a description which, even assisted by the art of the engraver will but confusedly represent the original In general it may be observed that the forehead is very high and rising the ears very large and dependent the eyes extremely small, the proboscis or trunk long the body round and full the back rising in an arch and the whole animal short in proportion to its height The feet are round at the bottom on each foot there are five flat horny risings which seem to be the extremities of the toes but do not appear outwardly The hide is without hair full of scratches and scars which it receives in its passage through thick woods and thorny places At the end of the tail there is a tuft of hair a foot and half long The female is less than the male and the udder is between the fore legs But a more accurate as well as a more entertaining description of the parts will naturally occur in the history of their uses

Of all quadrupeds the elephant is the strongest as well as the largest and yet in a state of nature it is neither fierce nor formidable * Mild peaceful and brave it never abuses its power or its strength and only uses its force for its own protection or that of its community In its native deserts the elephant is seldom seen alone but appears to be a social friendly creature The oldest of the company conducts the band that which is next in seniority brings up the rear The young the weak and the sickly fall into the centre while the females carry their young and keep them from falling by means of their trunks They maintain this order only in dangerous marches or when they desire to feed in cultivated grounds they move with less precaution in the forests and solitudes but without ever separating or removing so far asunder as to be incapable of lending each other any requisite assistance Nothing can be more formidable than a drove of elephants as they appear at a distance in an African landscape wherever they march the forests seem to fall before them in their passage they bear

* I have extracted the greatest part of this description from Mr Buffon Where I add I mark with commas thus

down the branches upon which they feed, and if they enter into an enclosure, they destroy all the labours of the husbandman in a very short time. Their invasions are the more disagreeable, as there is no means of repelling them, since it would require a small army to attack the whole drove when united. It now and then happens that one or two is found lingering behind the rest, and it is against these that the art and force of the hunters are united, but an attempt to molest the whole body would certainly be fatal. They go forward directly against him who offers the insult, strike him with their tusks, seize him with their trunks, fling him into the air, and then trample him to pieces under their feet. But they are thus dreadful only when offended, and do no manner of personal injury when suffered to feed without interruption. It is even said that they are mindful of injuries received, and when once molested by man seek all occasions for the future to be revenged, they smell him with their long trunks at a distance, follow him with all their speed upon the scent; and though slow to appearance they are soon able to come up with and destroy him.

In their natural state they delight to live along the sides of rivers, to keep in the deepest vales, to refresh themselves in the most shady forests and watery places. They cannot live far from the water, and they always disturb it before they drink. They often fill their trunk with it either to cool that organ, or to divert themselves by spurring it out like a fountain. They are equally distressed by the extremes of heat and cold, and to avoid the former, they frequently take shelter in the most obscure recesses of the forest, or often plunge into the water, and even swim from the continent into islands some leagues distant from the shore.

Their chief food is of the vegetable kind, for they loathe all kind of animal diet. When one among their number happens to light upon a spot of good pasture, he calls the rest, and invites them to share in the entertainment, but it must be very copious pasture indeed that can supply the necessities of the whole band. As with their broad and heavy feet they sink deep wherever they go, they destroy much more than they devour, so that they are frequently obliged to change their quarters, and to migrate from one country to another. The Indians and negroes, who are often incom-

moded by such visitants do all they can to keep them away making loud noises and large fires round their cultivated grounds but these precautions do not always succeed, the elephants often break through their fences destroy their whole harvest and overturn their little habitations. When they have satisfied themselves and trod down or devoured whatever lay in their way they then retreat into the woods in the same orderly manner in which they made their irruption.

Such are the habits of this animal considered in a social light, and if we regard it as an individual we shall find its powers still more extraordinary. With a very awkward appearance it possesses all the senses in great perfection and is capable of applying them to more useful purposes than any other quadruped. The elephant as we observed has very small eyes when compared to the enormous bulk of its body. But though their minuteness may at first sight appear deformed yet when we come to examine them they are seen to exhibit a variety of expression and to discover the various sensations with which it is moved. It turns them with attention and friendship to its master, it seems to reflect and deliberate and as its passions slowly succeed each other their various workings are distinctly seen.

The elephant is not less remarkable for the excellence of its hearing. Its ears are extremely large and greater in proportion than even those of an ass. They are usually dependent, but it can readily raise and move them. They serve also to wipe its eyes and to protect them against the dust and flies that might otherwise incommode them. It appears delighted with music and very readily learns to beat time to move in measure and even to join its voice to the sound of the drum and the trumpet.

This animal's sense of smelling is not only exquisite but it is in a great measure pleased with the same odours that delight mankind. The elephant gathers flowers with great pleasure and attention it picks them up one by one unites them into a nosegay and seems charmed with the perfume. The orange flower seems to be particularly grateful both to its sense of taste and smelling it strips the tree of all its verdure and eats every part of it even to the branches.

themselves It seeks in the meadows the most odouriferous plants to feed upon, and in the woods it prefers the cocoa, the banana, the palm, and the sago-tree, to all others As the shoots of these are tender, and filled with pith, it eats not only the leaves and the fruits, but even the branches, the trunk, and the whole plant to the very roots.

But it is in the sense of touching that this animal excels all others of the brute creation, and perhaps even man himself The organ of this sense lies wholly in the trunk, which is an instrument peculiar to this animal, and that serves it for all the purposes of a hand The trunk is, properly speaking, only the snout lengthened out to a great extent, hollow like a pipe, and ending in two openings, or nostrils, like those of a hog. An elephant of fourteen feet high has the trunk about eight feet long, and five feet and a half in circumference at the mouth, where it is thickest It is hollow all along, but with a partition running from one end of it to the other, so that though outwardly it appears like a single pipe, it is inwardly divided into two This fleshy tube is composed of nerves and muscles, covered with a proper skin of a blackish colour, like that of the rest of the body It is capable of being moved in every direction, of being lengthened and shortened, of being bent and straightened, so pliant as to embrace any body it is applied to, and yet so strong that nothing can be torn from the gripe To aid the force of this grasp, there are several little eminences, like a caterpillar's feet, on the underside of this instrument, which, without doubt, contribute to the sensibility of the touch, as well as to the firmness of the hold Though this trunk the animal breathes, drinks, and smells, as through a tube, and at the very point of it, just above the nostrils, there is an extension of the skin, about five inches long, in the form of a finger, and which, in fact, answers all the purposes of one, for, with the rest of the extremity of the trunk, it is capable of assuming different forms at will, and consequently of being adapted to the minutest objects By means of this, the elephant can take a pin from the ground, untie the knots of a rope, unlock a door, and even write with a pen "I have myself seen," says *Ælian*, "an elephant writing Latin characters on a board, in a very orderly manner, his keeper only shewing him the figure of each letter While thus employed, the eyes might be observed studiously cast down

upon the writing and exhibiting an appearance of great skill and erudition." It sometimes happens that the object is too large for the trunk to grasp in such a case the elephant make use of another expedient as admirable as any of the former. It applies the extremity of the trunk to the surface of the object and sucking up its breath lifts and sustains such a weight as the air in that case is capable of keeping suspended. In this manner this instrument is useful in most of the purposes of life. It is an organ of smelling of touching and of suction. It not only provides for the animal's necessities and comforts but it also serves for its ornament and defence.

But though the elephant be thus admirably supplied by its trunk yet with respect to the rest of its conformation it is unwieldy and helpless. The neck is so short that it can scarcely turn the head and must wheel round in order to discover an enemy from behind. The hunters that attack it upon that quarter generally thus escape the effects of its indignation and find time to renew their assaults while the elephant is turning to free them. The legs are indeed not so inflexible as the neck yet they are very stiff and bend not without difficulty. Those before seem to be longer than the hinder but upon being measured are found to be something shorter. The joints by which they bend are nearly in the middle like the knee of a man and the great bulk which they are to support makes their flexure ungainly. While the elephant is young it bends the legs to lie down or to rise but when it grows old or sickly this is not performed without human assistance and it becomes consequently so inconvenient that the animal chooses to sleep standing. The feet upon which these massy columns are supported form a base scarcely broader than the legs they sustain. They are divided into five toes which are covered beneath the skin and none of which appear to the eye. A kind of protuberance like claws are only observed which vary in number from three to five. The apparent claws vary the internal toes are constantly the same. The sole of the foot is furnished with a skin as thick and hard as horn and which completely covers the whole under part of the foot.

To the rest of the elephant's incumbrances may be added its enormous tusks which are unserviceable for chewing and are only weapons of defence. These as the animal

grows old, become so heavy, that it is sometimes obliged to make holes in the walls of its stall to rest them in, and ease itself of the fatigue of their support. It is well known to what an amazing size these tusks grow, they are two in number, proceeding from the upper jaw, and are sometimes found above six feet long. Some have supposed them to be rather the horns than the teeth of this animal, but, besides their greater similitude to bone than to horn, they have been indisputably found to grow from the upper jaw, and not from the frontal bones, as some have thought proper to assert *. Some also have asserted, that these tusks are shed in the same manner as the stag sheds its horns, but it is very probable, from their solid consistence, and from their accidental defects, which often appears to be the effect of a slow decay, that they are as fixed as the teeth of other animals are generally found to be. Certain it is that the elephant never sheds them in a domestic state, but keeps them till they become inconvenient and encumbersome to the last degree. An account of the uses to which these teeth are applied, and the manner of choosing the best ivory, belongs rather to a history of the arts than of nature.

This animal is equally singular in other parts of its conformation; the lips and the tongue in other creatures serve to suck up and direct their drink or their food, but in the elephant they are totally inconvenient for such purposes; and it not only gathers its food with its trunk, but supplies itself with water by the same means. When it eats hay, as I have seen it frequently, it takes up a small wisp of it with the trunk, turns and shapes it with that instrument for some time, and then directs it into the mouth, where it is chewed by the great grinding-teeth, that are large in proportion to the bulk of the animal. This packet, when chewed, is swallowed, and never ruminated again, as in cows or sheep, the stomach and intestines of this creature more resembling those of a horse. Its manner of drinking is equally extraordinary. For this purpose the elephant dips the end of its trunk into the water, and sucks up just as much as fills that great fleshy tube completely. It then lifts up its head with the trunk full, and turning the point into its mouth, as if it intended to swallow trunk and all, it dives the point below

* See Mr Daubenton's description of the skeleton of this animal

the opening of the wind pipe. The trunk being in this position and still full of water the elephant then blows strongly into it at the other end which forces the water it contains into the throat, down which it is heard to pour with a loud gurgling noise which continues till the whole is blown down. From this manner of drinking, some have been led into an opinion that the young elephant sucks with its trunk, and not with its mouth. This however is a fact which no traveller has hitherto had an opportunity of seeing and it must be referred to some future accident to determine.*

The hide of the elephant is as remarkable as any other part. It is not covered over with hair as in the generality of quadrupeds but is nearly bare. Here and there indeed a few bristles are seen growing in the scars and wrinkles of the body but very thinly scattered over the rest of the skin, but in general the head is dry, rough and wrinkled and resembling more the bark of an old tree than the skin of an animal. This grows thicker every year and by a constant addition of substance it at length contracts that disorder well known by the name of the elephantiasis or Arabian leprosy a disease to which man as well as the elephant, is often subject. In order to prevent this the Indians rub the elephant with oil and frequently bathe it to preserve its pliancy. To the inconveniences of this disorder is added another arising from the great sensibility of those parts that are not callous. Upon these the flies settle in great abundance and torment this animal unceasingly to remedy which the elephant tries all its arts using not only its tail and trunk in the natural manner to keep them off but even takes the branch of a tree or a bundle of hay to strike them off with. When this fails it often gathers up the dust with its trunk and thus covers all the sensible places. In this manner it has been seen to dust itself several times a day and particularly upon leaving the bath.

Water is as necessary to this animal as food itself. When in a state of nature the elephant rarely quits the banks of

* The young elephant it is now known does not suck by the trunk quadrupeds during which the the head. It is however highly that they do not attach themselves to the r dams in particular but suck indiscriminately the females of the whole herd.

the river, and often stands in water up to the belly. In a state of servitude, the Indians take equal care to provide a proper supply, they wash it with great address, they give it all the conveniences for lending assistance to itself, they smooth the skin with a pumice-stone, and then rub it over with oils, essences, and odours.

It is not to be wondered at that an animal furnished with so many various advantages, both of strength, sagacity, and obedience, should be taken into the service of man. We accordingly find that the elephant, from time immemorial, has been employed either for the purposes of labour, of war, or of ostentation, to increase the grandeur of eastern princes, or to extend their dominions. We have hitherto been describing this animal in its natural state, we now come to consider it in a different view, as taken from the forest, and reduced to human obedience. We are now to behold this brave harmless creature as learning a lesson from mankind, and instructed by him in all the arts of war, massacre, and devastation. We are now to behold this half-reasoning animal led into the field of battle, and wondering at those tumults and that madness which he is compelled to increase. The elephant is a native of Africa and Asia, being found neither in Europe nor America. In Africa he still retains his natural liberty. The savage inhabitants of that part of the world, instead of attempting to subdue this powerful creature to their necessities, are happy in being able to protect themselves from his fury. Formerly, indeed, during the splendour of the Carthaginian empire, elephants were used in their wars, but this was only a transitory gleam of human power in that part of the globe, the natives of Africa have long since degenerated, and the elephant is only known among them from his devastations. However, there are no elephants in the northern parts of Africa at present, there being none found on this side of Mount Atlas. It is beyond the river Senegal that they are to be met with in great numbers, and so down to the Cape of Good Hope, as well as in the heart of the country. In this extensive region they appear to be more numerous than in any other part of the world. They are there less fearful of man, less retired into the heart of the forests, they seem to be sensible of his impotence and ignorance, and often come down to ravage his little labours. They treat him with the same haughty dis-

dom which they shew to other animals and consider him as a mischievous little being that fears to oppose them openly

But although these animals are most plentiful in Africa it is only in Asia that the greatest elephants are found and rendered subservient to human command In Africa the largest do not exceed ten feet high, in Asia they are found from ten to fifteen Their price increases in proportion to their size and when they exceed a certain bulk like jewels their value then rises as the fancy is pleased to estimate

The largest are entirely kept for the service of princes and are maintained with the utmost magnificence and at the greatest expense The usual colour of the elephant is a dusky black but some are said to be white and the price of one of these is inestimable Such a one is peculiarly appropriated for the monarch's own riding he is kept in a palace attended by the nobles and almost adored by the people * Some have said that these white elephants are larger than the rest † others assert that they are less and still others entirely doubt their existence

As the art of war is but very little improved in Asia there are few princes of the East who do not procure and maintain as many elephants as they are able and place great confidence on their assistance in an engagement For this purpose they are obliged to take them wild in their native forests and tame them for the elephant never breeds in a state of servitude It is one of the most striking peculiarities in this extraordinary creature that his generative powers totally fail when he comes under the dominion of man as if he seemed unwilling to propagate a race of slaves to increase the pride of his conqueror There is perhaps no other quadruped that will not breed in its own native climate if indulged with a moderate share of freedom and we know that many of them will copulate in every climate The elephant alone has never been seen to breed and though he has been reduced under the obedience of man for ages the duration of pregnancy in the female ‡ still remains a secret Aristotle

* P Vincent Marie

† P Tachard

‡ Multis persuasum est elephantem non brutorum sed hominum more

indeed, asserts, that she goes two years with young; that she continues to suckle her young for three years, and that she brings forth but one at a time but he does not inform us of the manner in which it was possible for him to have his information. From authorities equally doubtful, we learn, that the little one is about as large as a wild boar the instant it is brought forth, that its tusks do not yet appear, but that all the rest of its teeth are apparent, that at the age of six months, it is as large as an ox, and its tusks pretty well grown; and that it continues in this manner, for near thirty years, advancing to maturity. All this is doubtful, but it is certain that, in order to recruit the numbers which are consumed in war, the princes of the East are every year obliged to send into the forests, and to use various methods to procure a fresh supply. Of all these numerous bands, there is not one that has not been originally wild, nor one that has not been forced into a state of subjection. Men themselves are often content to propagate a race of slaves, that pass down in this wretched state through successive generations but the elephant, under subjection, is unalterably barren, perhaps from some physical causes, which are as yet unknown.

The Indian princes having vainly endeavoured to multiply the breed of elephants, like that of other animals, have been at last content to separate the males from the females, to prevent those accesses of desire, which debilitated without multiplying the species. In order to take them wild in the woods, a spot of ground is fixed upon, which is surrounded with a strong palisade. This is made of the thickest and the strongest trees, and strengthened by cross bars, which give firmness to the whole. The posts are fixed at such distances from each other that a man can easily pass between them; there being only one great passage left open, through which an elephant can easily come, and which is so contrived as to shut behind, as soon as the beast is entered. To draw him into this enclosure, it is necessary first to find him out in the woods, and a female elephant is conducted along into the heart of the forest, where it is obliged by its keeper to cry out for the male. The male very readily answers the cry, and hastens to join her, which the keeper perceiving, obliges her to retreat, still repeating the same cry, until she leads the animal into the enclosure.

already described which shut the moment he is entered. Still however the female proceeds calling and inviting while the male proceeds forward in the enclosure which grows narrower all the way and until the poor animal finds himself completely shut up without the power of either advancing or retreating, the female in the mean time being let out by a private way, which she has been previously accustomed to. The wild elephant upon seeing himself entrapped in this manner instantly attempts to use violence, and upon seeing the hunters all his former desires only turn to fury. In the mean time the hunters having fixed him with cords attempt to soften his indignation by throwing buckets of water upon him in great quantities rubbing the body with leaves and pouring oil down his ears. Soon after two tame elephants are brought, a male and a female that caress the indignant animal with their trunks while they still continue pouring water to refresh it. At last a tame elephant is brought forward of that number which is employed in instructing the new comers and an officer riding upon it in order to shew the late captive that it has nothing to fear. The hunters then open the enclosure and while this creature leads the captive along two more are joined on either side of it and these compel it to submit. It is then tied by cords to a mossy pillar provided for that purpose and suffered to remain in that position for about a day and a night until its indignation be wholly subsided. The next day it begins to be somewhat submissive and in a fortnight is completely tamed like the rest. The females are taken when accompanying the males, they often come into these enclosures and they shortly after serve as decoys to the rest. But the method of taking the elephant differs according to the abilities of the hunter the negroes of Africa who hunt this animal merely for its flesh are content to take it in pit falls and often to pursue it in the defiles of a mountain where it cannot easily turn and so wound it from behind till it falls.

The elephant when once tamed becomes the most gentle and obedient of all animals. It soon conceives an attachment for the person that attends it caresses him obeys him and seems to anticipate his desires. In a short time it begins to comprehend several of the signs made to it and

even the different sounds of the voice; it perfectly distinguishes the tone of command from that of anger or approbation, and acts accordingly. It is seldom deceived in its master's voice, it receives his orders, with attention, and executes them with prudence, eagerly, yet without precipitation. All its motions are regulated, and its actions seem to partake of its magnitude, being grave, majestic, and secure. It is quickly taught to kneel down, to receive its rider; it caresses those it knows with its trunk, with this salutes such as it is ordered to distinguish, and with this, as with a hand, helps to take up a part of its load. It suffers itself to be arrayed in harness, and seems to take a pleasure in the finery of its trappings. It draws either chariots, cannon, or shipping, with surprising strength and perseverance, and this with a seeming satisfaction, provided that it be not beaten without a cause, and that its master appears pleased with its exertions.

The elephant's conductor is usually mounted upon its neck, and makes use of a rod of iron to guide it, which is sometimes pointed, and at others bent into a hook. With this the animal is spurred forward when dull or disobedient, but, in general, a word is sufficient to put the gentle creature into motion, especially when it is acquainted with its conductor. This acquaintance is often perfectly necessary, for the elephant frequently takes such an affection to its keeper, that it will obey no other, and it has been known to die for grief, when, in some sudden fit of madness, it has killed its conductor. We are told, that one of these, that was used by the French forces in India for the drawing their cannon, was promised, by the conductor, a reward, for having performed some painful service; but being disappointed of its expectations, it slew him in a fury. The conductor's wife, who was a spectator of this shocking scene, could not restrain her madness and despair, but running with her two children in her arms, threw them at the elephant's feet, crying out, that since it had killed her husband, it might kill her and her children also. The elephant, seeing the children at its feet, instantly stopped, and moderating its fury, took up the eldest with its trunk, and placing him upon its neck, adopted him for its conductor, and obeyed him ever after with great punctuality.

But it is not for drawing burdens alone, that the ele-

phants are serviceable in war they are often brought into the ranks and compelled to fight in the most dangerous parts of the field of battle. There was a time indeed in India when they were much more used in war than at present. A century or two ago a great part of the dependence of the general was upon the number and the expertness of his elephants, but of late since war has been contented to adopt fatal instead of formidable arts the elephant is little used, except for drawing cannon or transporting provisions. The princes of the country are pleased to keep a few for ornament or for the purposes of removing their seraglios but they are seldom led into a field of battle where they are unable to withstand the discharge of fire arms and have often been found to turn upon their employers. Still however they are used in war in the more remote parts of the East, in Siam in Cochinchina in Tonquin and Pegu. In all these places they not only serve to swell the pomp of state being adorned with all the barbarian splendour that those countries can bestow but they are actually led into the field of battle armed before with coats of mail and larded on the back each with a square tower containing from five combatants to seven. Upon its neck sits the conductor who girds the animal into the thickest ranks and encourages it to increase the devastation wherever it goes nothing can withstand its fury it levels the ranks with its immense bulk flings such as oppose it into the air or crushes them to death under its feet. In the mean time those who are placed upon its back combat as from an eminence and fling down their weapons with double force their weight being added to their velocity. Nothing therefore can be more dreadful or more irresistible than such a moving machine to men unacquainted with the modern arts of war the elephant thus armed and conducted raging in the midst of the field of battle inspires more terror than even those machines that destroy at a distance and are often most fatal when most unseen. But this method of combating is rather formidable than effectual polished nations have ever been victorious over those semi barbarous troops that have called in the elephant to their assistance or attempted to gain a victory by merely astonishing their opposers. The Romans quickly learned the art of opening

then ranks to admit the elephant, and thus separating it from assistance, quickly compelled its conductors to calm the animals' fury, and to submit. It sometimes also happened that the elephant became impatient of control, and, instead of obeying its conductor, turned upon those forces it was employed to assist. In either case, there was a great deal of preparation to very little effect, for a single elephant is known to consume as much as forty men in a day.

At present, therefore, they are chiefly employed in carrying, or drawing burdens, throughout the whole Peninsula of India; and no animal can be more fitted by nature for this employment. The strength of an elephant is equal to its bulk, for it can, with great ease, draw a load that six horses could not remove, it can readily carry upon its back three or four thousand weight, upon its tusks alone it can support near a thousand. Its force may also be estimated from the velocity of its motion, compared to the mass of its body. It can go, in its ordinary pace, as fast as a horse at an easy trot, and, when pushed, it can move as swiftly as a horse at full gallop. It can travel with ease fifty or sixty miles a day, and, when hard pressed, almost double that distance. It may be heard trotting on at a great distance, it is easy also to follow it by the track, which is deeply impressed on the ground, and from fifteen to eighteen inches in diameter.

In India they are also put to other very disagreeable offices, for in some courts of the more barbarous princes they are used as executioners, and this horrid task they perform with great dexterity. With their trunks they are seen to break every limb of the criminal at the word of command, they sometimes trample him to death, and sometimes impale him on their enormous tusks, as directed. In this the elephant is rather the servant of a cruel master than a voluntary tyrant, since no other animal of the forest is so naturally benevolent and gentle, equally mindful of benefits as sensible of neglect, he contracts a friendship for his keeper, and obeys him even beyond his capacity.

In India, where they were at one time employed in launching ships, a particular elephant was directed to force a very large vessel into the water. The work proved superior to its strength, but not to its endeavours, which, however, the keeper affected to despise. "Take away," says he, "that lazy beast, and bring another better fitted for service." The

poor animal instantly upon this redoubled its efforts fractured its skull and died upon the spot

In Delhi an elephant passing along the streets put his trunk into a tailor's shop where several people were at work One of the persons of the shop desirous of some amusement pricked the animal's trunk with his needle and seemed highly delighted with this slight punishment The elephant however passed on without any immediate signs of resentment but coming to a puddle filled with dirty water he filled his trunk returned to the shop and spurted the contents over all the finery upon which the tailors were then employed

An elephant in Adsmeer which often passed through the bazar or market as he went by a certain herb woman always received from her a mouthful of greens Being one day seized with a periodical fit of madness he broke his fetters and running through the market, put the crowd to flight and among others this woman who in her haste forgot a little child at her stall The elephant recollecting the spot where its benefactress was accustomed to sit took up the infant gently in its trunk and conveyed it to a place of safety

At the Cape of Good Hope it is customary to hunt those animals for the sake of their teeth Three horsemen well mounted and armed with lances attack the elephant alternately each relieving the other as they see their companion pressed till the beast is subdued Three Dutchmen brothers who had made large fortunes by this business determined to retire to Europe and enjoy the fruits of their labours but they resolved one day before they went to have a last chase by way of amusement they met with their game and began their attack in the usual manner but unfortunately one of their horses falling happened to fling his rider the enraged elephant instantly seized the unhappy huntsman with his trunk flung him up to a vast height in the air and received him upon one of the tusks as he fell and then turning towards the other two brothers as if it were with an aspect of revenge and insult held out to them the impaled wretch writhing in the agonies of death

The teeth of the elephant are what produce the great enmity between him and mankind but whether they are shed like the horns of the deer or whether the animal be killed

to obtain them, is not yet perfectly known All we have as yet certain is, that the natives of Africa, from whence almost all our ivory comes, assure us that they find the greatest part of it in their forests, nor would, say they, the teeth of an elephant recompense them for their trouble and danger in killing it notwithstanding, the elephants which are tamed by man are never known to shed their tusks, and from the hardness of their substance, they seem no way analogous to deers' horns

The teeth of the elephant are very often found in a fossil state Some years ago, two great grinding-teeth, and part of the tusk of an elephant, were discovered at the depth of forty-two yards in a lead-mine in Flintshire *

The tusks of the Mammoth, so often found fossil in Siberia, and which are converted to the purposes of ivory, are generally supposed to belong to the elephant however, the animal must have been much larger in that country than it is found at present, as those tusks are often known to weigh four hundred pounds, while those that come from Africa seldom exceed two hundred and fifty These enormous tusks are found lodged in the sandy banks of the Siberian rivers, and the natives pretend that they belong to an animal which is four times as large as the elephant

There have lately been discovered several enormous skeletons, five or six feet beneath the surface, on the banks of the Ohio, not remote from the river Miume, in America, seven hundred miles from the sea-coast Some of the tusks are near seven feet long, one foot nine inches in circumference at the base, and one foot near the point; the cavity at the root or base nineteen inches deep Besides their size, there are yet other differences the tusks of the true elephant have sometimes a very slight lateral bend, these have a larger twist, or spiral curve, towards the smaller end but the great and specific difference consists in the shape of the grinding-teeth, which, in these newly found, are fashioned like the teeth of a carnivorous animal, not flat and ribbed transversely on their surface, like those of the modern elephant, but furnished with a double row of high and conic processes, as if intended to masticate, not to grind their food A third difference is in the thigh-bone, which is of a great

* Pennant's Synopsis, p 90

disproportionable thickness to that of the elephant and has also some other anatomical variations. These fossil bones have been also found in Peru and the Brazils and when cut and polished by the workers in ivory appear in every respect similar. It is the opinion of Dr Hunter that they must have belonged to a larger animal than the elephant and differing from it in being carnivorous. But as yet this formidable creature has evaded our search and if indeed such an animal exists it is happy for man that it keeps at a distance since what savage might not be expected from a creature endued with more than the strength of the elephant and all the rapacity of a tiger!

CHAP. III

OF THE RHINOCEROS

NEXT to the Elephant the Rhinoceros is the most powerful of animals. It is usually found twelve feet long from the tip of the nose to the insertion of the tail from six to seven feet high and the circumference of its body is nearly equal to its length. It is therefore equal to the elephant in bulk and if it appears much smaller to the eye the reason is that its legs are much shorter. Words can convey but a very confused idea of this animal's shape and yet there are few so remarkably formed. Its head is furnished with a horn growing from the snout sometimes three feet and a half long and but for this that part would have the appearance of the head of a hog. The upper lip however is much longer in proportion ends in a point is very pliable serves to collect its food and deliver it into the mouth. The ears are large erect and pointed. The eyes are small and piercing, the skin is naked rough knotty and lying upon the body in folds after a very peculiar fashion. There are two folds very remarkable one above the shoulders and another over the rump. The skin which is of a dirty brown colour is so thick as to turn the edge of a scimitar and to resist a musket ball. The belly hangs low the legs are short strong and thick and the hoofs divided into three parts each pointing forward.

Such is the general outline of an animal that appears chiefly formidable from the horn growing from its snout, and formed rather for war than with a propensity to engage. This horn is sometimes found from three to three feet and a half long, growing from the solid bone, and so disposed as to be managed to the greatest advantage. It is composed of the most solid substance, and pointed so as to inflict the most fatal wounds. The elephant, the boar, or the buffalo, are obliged to strike transversely with their weapons, but the rhinoceros employs all his force with every blow, so that the tiger will more willingly attack any other animal of the forest, than one whose strength is so justly employed. Indeed, there is no force which this terrible animal has to apprehend. defended, on every side, by a thick thorny hide, which the claws of the lion or the tiger are unable to pierce, and armed before with a weapon that even the elephant does not choose to oppose. The missionaries assure us, that the elephant is often found dead in the forests, pierced with the horn of a rhinoceros, and though it looks like wisdom to doubt whatever they tell us, yet I cannot help giving credit to what they relate on this occasion, particularly when confirmed by Pliny. The combat between these two, the most formidable animals of the forest, must be very dreadful. Emanuel, king of Portugal, willing to try their strength, actually opposed them to each other, and the elephant was defeated.

But though the rhinoceros is thus formidable by nature, yet imagination has not failed to exert itself, in adding to its terrors. The scent is said to be most exquisite, and it is affirmed that it consorts with the tiger. It is reported also, that when it has overturned a man, or any other animal, it continues to lick the flesh quite from the bone with its tongue, which is said to be extremely rough. All this, however, is fabulous. the scent, if we may judge from the expansion of the olfactory nerves, is not greater than that of a hog, which we know to be indifferent, it keeps company with the tiger, only because they both frequent watery places in the burning climates where they are bred, and as to its rough tongue, that is so far from the truth, that no animal of near its size has so soft a one. "I have often felt it myself," says Ladvocat, in his description of this

animal ' it is smooth soft and small like that of a dog, and to the feel it appears as if one passed the hand over velvet I have often seen it lick a young man's face who kept it and both seemed pleased with the action

The rhinoceros which was shown at London in 1739 and described by Dr Parsons had been sent from Bengal Though it was very young not being above two years old yet the charge of his carriage and food from India cost near a thousand pounds It was fed with rice sugar and hay it was daily supplied with seven pounds of rice mixed with three of sugar divided into three portions it was given great quantities of hay and grass which it chiefly preferred its drink was water which it took in great quantities It was of a gentle disposition and permitted itself to be touched and handled by all visitors never attempting mischief except when abused or when hungry, in such a case there was no method of appeasing its fury but by giving it something to eat When angry it would jump up against the walls of its room with great violence and made many efforts to escape but seldom attempted to attack its keeper and was always submissive to his threats It had a peculiar cry somewhat a mixture between the grunting of a hog and the bellowing of a calf

The age of these animals is not well known it is said by some that they bring forth at three years old and if we may reason from analogy it is probable they seldom live till above twenty That which was shown in London was said by its keeper to be eighteen years old and even at that age he pretended to consider it as a young one however it died shortly after and that probably in the course of nature

The rhinoceros is a native of the deserts of Asia and Africa and is usually found in those extensive forests that are frequented by the elephant and the lion As it subsists entirely upon vegetable food it is peaceful and harmless among its fellows of the brute creation but though it never provokes to combat it equally disdains to fly It is every way fitted for war but rests content in the consciousness of its security It is particularly fond of the prickly branches of trees and is seen to feed upon such thorny shrubs as would be dangerous to other animals either to

gather or to swallow The prickly points of these, however, may only serve to give a poignant relish to this animal's palate, and may answer the same grateful ends in seasoning its banquet that spices do in heightening ours

In some parts of the kingdom of Asia, where the natives are more desirous of appearing warlike than shewing themselves brave, these animals are tamed, and led into the field to strike terror into the enemy, but they are always an unmanageable and restive animal, and probably more dangerous to the employers than those whom they are brought to oppose.

The method of taking them is chiefly watching them, till they are found either in some moist or marshy place, where, like hogs, they are fond of sleeping and wallowing They then destroy the old one with fire-arms, for no weapons that are thrown by the force of man are capable of entering this animal's hide If, when the old one is destroyed, there happens to be a cub, they seize and tame it these animals are sometimes taken in pit-falls, covered with green branches, laid in those paths which the rhinoceros makes in going from the forest to the river side.

There are some varieties in this animal, as in most others, some of them are found in Africa with a double horn, one growing above the other. This weapon, if considered in itself, is one of the strongest and most dangerous that nature furnishes to any part of the animal creation The horn is entirely solid, formed of the hardest bony substance, growing from the upper maxillary bone, by so strong an apophyse, as seemingly to make but one part with it Many are the medicinal virtues that are ascribed to this horn, when taken in powder, but these qualities have been attributed to it without any real foundation, and make only a small part of the many fables which this extraordinary animal has given rise to.

CHAP. IV

THE HIPPOPOTAMUS

THE Hippopotamus is an animal as large and not less formidable than the rhinoceros its legs are shorter and its head rather more bulky than that of the animal last described. We have had but few opportunities in Europe of examining this formidable creature minutely its dimensions however have been pretty well ascertained by a description given us by Zeranghi an Italian surgeon who procured one of them to be killed on the banks of the river Nile. By his account it appears that this terrible animal which chiefly resides in the waters of that river is above seventeen feet long from the extremity of the snout to the insertion of the tail above sixteen feet in circumference round the body and above seven feet high the head is near four feet long and above nine feet in circumference. The jaws open about two feet wide and the cutting teeth of which it hath four in each jaw are above a foot long.

Its feet in some measure resemble those of the elephant and are divided into four parts. The tail is short flat and pointed the hide is amazingly thick and though not capable of turning a musket ball is impenetrable to the blow of a sabre the body is covered over with a few scattered hairs of a whitish colour. The whole figure of the animal is something between that of an ox and a hog and its cry is something between the bellowing of the one and the grunting of the other.

This animal however though so terribly furnished for war seems no way disposed to make use of its prodigious strength against an equal enemy it chiefly resides at the bottom of the great rivers and lakes of Africa the Nile the Niger and the Zaire there it leads an indolent kind of life and seems seldom disposed for action except when excited by the calls of hunger. Upon such occasions three or four of them are often seen at the bottom of a river near some cataract forming a kind of line and seizing upon such fish as are forced down by the violence of the stream. In that element they pursue their prey with great swiftness and perseverance they swim with much force and remain at

the bottom for thirty or forty minutes, without rising to take breath. They traverse the bottom of the stream, as if walking upon land, and make a terrible devastation where they find plenty of prey. But it often happens, that this animal's fishy food is not supplied in sufficient abundance, it is then forced to come upon land, where it is an awkward and unwieldy stranger, it moves but slowly, and as it seldom forsakes the margin of the river, it sinks at every step it takes; sometimes, however, it is forced by famine up into the higher grounds, where it commits dreadful havoc among the plantations of the helpless natives, who see their possessions destroyed, without daring to resist their invader. Their chief method is by lighting fires, striking drums, and raising a cry to frighten it back to its favourite element; and as it is extremely timorous upon land, they generally succeed in their endeavours. But if they happen to wound, or otherwise irritate it too closely, it then becomes formidable to all that oppose it. It overturns whatever it meets, and brings forth all its strength, which it seemed not to have discovered before that dangerous occasion. It possesses the same inoffensive disposition in its favourite element, that it is found to have upon land, it is never found to attack the mariners in their boats as they go up or down the stream, but should they inadvertently strike against it, or otherwise disturb its repose, there is much danger of its sending them at once to the bottom. "I have seen," says a mariner, as we find it in Dampier, "one of these animals open its jaw, and seizing a boat between its teeth, at once bite and sink it to the bottom. I have seen it, upon another occasion, place itself under one of our boats, and, rising under it, upset it, with six men who were in it, who, however, happily received no other injury." Such is the great strength of this animal, and from hence, probably, the imagination has been willingly to match it in combat against others more fierce, and equally formidable. The crocodile and shark have been said to engage with it, and yield an easy victory; but as the shark is only found at sea, and the hippopotamus never ventures beyond the mouth of fresh-water rivers, it is most probable that these engagements never occurred; it sometimes happens, indeed, that the princes of Africa amuse themselves with combats, on their fresh-water lakes, between this and other formidable animals, but whether the rhinoceros or

the crocodile are of this number we have not been particularly informed. If this animal be attacked on land, and finding itself incapable of vengeance from the swiftness of its enemy it immediately returns to the river where it plunges in head foremost and after a short time, rises to the surface loudly bellowing either to invite or intimidate the enemy but though the negroes will venture to attack the shark or the crocodile in their natural element, and there destroy them they are too well apprised of the force of the hippopotamus to engage it this animal therefore continues the uncontrolled master of the river and all others fly from
 a good and easy prey

upon fish and vegetables so it
 terrestrial animals may be equally
 grateful the natives of Africa assert that it has often been
 to devour children and other creatures that it was able
 to surprise upon land yet as it moves but slowly almost
 every creature, endued with a common share of swiftness is
 able to escape it and this animal therefore seldom ventures
 from the river side but when pressed by the necessities
 of hunger or of bringing forth its young

The female always comes upon land to bring forth and it is supposed that she seldom produces above one at a time. Upon this occasion these animals are particularly timorous and dread the approach of a terrestrial enemy the instant the parent hears the slightest noise it dashes into the stream, and the young one is seen to follow it with equal alacrity.

The young ones are said to be excellent eating but the negroes to whom nothing that has life comes amiss find an equal delicacy in the old. Dr Pococke has seen their flesh sold in the shambles like beef, and it is said that their breast in particular is as delicate eating as veal. As for the rest these animals are found in great numbers and as they produce very fast their flesh might supply the countries where they are found could those barbarous regions produce more expert huntsmen. It may be remarked however that this creature which was once in such plenty at the mouth of the Nile is now wholly unknown in Lower Egypt and is no where to be found in that river except above the cataracts.

CHAP. V.

THE CAMELOPARD.

WERE we to be told of an animal so tall, that a man on horseback could with ease ride under its belly, without stooping, we should hardly give credit to the relation, yet of this extraordinary size is the camelopard, an animal that inhabits the deserts of Africa, and the accounts of which are so well ascertained, that we cannot deny our assent to their authority. It is no easy matter to form an adequate idea of this creature's size, and the oddity of its formation. It exhibits somewhat the slender shape of the deer, or the camel, but destitute of their symmetry, or their easy power of motion. The head somewhat resembles that of the deer, with two round horns, near a foot long, and which, it is probable, it sheds as deer are found to do; its neck resembles that of a horse; its legs and feet those of the deer, but with this extraordinary difference, that the fore-legs are near twice as long as the hinder. As these creatures have been found eighteen feet high, and ten from the ground to the top of the shoulder, so allowing three feet for the depth of the body, seven feet remains, which is high enough to admit a man mounted on a middle-sized horse. The hinder part, however, is much lower, so that when the animal appears standing, and at rest, it has somewhat the appearance of a dog sitting, and this formation of its legs gives it an awkward and a laborious motion, which, though swift, must yet be tiresome. For this reason the camelopard is an animal very rarely found, and only finds refuge in the most internal desert regions of Africa. The dimensions of a young one, as they were accurately taken by a person who examined its skin, that was brought from the Cape of Good Hope, were found to be as follow: the length of the head was one foot eight inches, the height of the fore-leg, from the ground to the top of the shoulder, was ten feet, from the shoulder to the top of the head was seven, the height of the hind-leg was eight feet five inches; and from the top of the shoulder to the insertion of the tail was just seven feet long.

No animal, either from its disposition, or its formation, seems less fitted for a state of natural hostility, its horns

are blunt and even knobbed at the ends its teeth are more entirely for vegetable pasture, its skin is beautifully speckled with brown spots upon a whitish ground, it is timorous and harmless and notwithstanding its great size rather flies from than resists the slightest enemy it partakes very much of the nature of the camel which it so nearly resembles it lives entirely upon vegetables and when grazing is obliged to spread its fore legs very wide in order to reach its pasture * its motion is a kind of pace two legs on each side moving at the same time whereas in other animals they move transversely It often lies down with its belly to the earth and like the camel has a callous substance upon its breast which when reposed defends it from injury This animal was known to the ancients but has been very rarely seen in Europe One of them was sent from the East to the Emperor of Germany in the year 1559 but they have often been seen since at Grand Cairo in Egypt and I am told there are two there at present When ancient Rome was in its splendour Pompey exhibited at one time no less than ten upon the theatre It was the barbarous pleasure of the people at that time to see the most terrible and the most extraordinary animals produced in combat against each other The lion the lynx the tiger the elephant the hippopotamus were all let loose promiscuously and were seen to inflict indiscriminate destruction

* Later naturalists say that this is a mistake and assert that as the neck is long and elegant and exceeds the legs by at least four inches besides the length of the head it is evident that it can graze without difficulty and is not obliged to kneel down (as has been supposed) or spread asunder its legs for that purpose

END OF THE SECOND VOLUME

